LABORATORY MANUAL
OF
FRUIT AND VEGETABLE PRODUCTS

(CREES AND CHRISTIE)

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BY

W. V. CRUESS, B. S.
ASSOCIATE PROFESSOR OF FRUIT PRODUCTS
UNIVERSITY OF CALIFORNIA COLLEGE OF AGRICULTURE

AND

A. W. CHRISTIE, M. S.
ASSISTANT PROFESSOR OF FRUIT PRODUCTS
UNIVERSITY OF CALIFORNIA COLLEGE OF AGRICULTURE

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PREFACE

Although food preservation has been definitely correlated with the development of modern civilization, it has been one of the last of the arts to attract the attention of scientific men. It is only within the past thirty years that the principles and practices of food preservation have received the intelligent investigation which they merit. Although there are yet many problems demanding solution, much has been accomplished toward an exact understanding of the scientific principles underlying the manufacture of food products.

The preparation and preservation of fruit and vegetable products have become of great economic importance, but this subject has not received the attention it deserves in the curricula of educational institutions. In many horticultural industries, manufacturing and marketing have become of as great importance as production. There is a rapidly growing demand for persons trained in the scientific principles underlying these industries. Practical knowledge alone no longer suffices.

This manual meets the need for a reliable guide in laboratory courses in colleges of agriculture, schools of domestic science, etc., in the manufacture, preservation and examination of fruit and vegetable products. It is the outgrowth of a course given at the University of California during the past eleven years.

The Assignments are designed to simulate as closely as is possible on a small scale present commercial practices as well as to illustrate the fundamental scientific principles involved. Although this manual should be supplemented by lectures or books giving correlated information, much valuable data are included, especially in tabular form.

Although intended primarily for use in Agricultural Colleges and Domestic Science schools, much of the information given is of value to growers, manufacturers of fruit and vegetable products, food inspectors and chemists, home demonstration agents and girls' club leaders, and teachers of Agriculture and of Domestic Science in secondary schools.

William V. Cruess.
Arthur W. Christie.

Berkeley, Cal.
June, 1922

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OF

FRUIT AND VEGETABLE PRODUCTS

ASSIGNMENT I.—DETERMINATION OF THE GRADE OF COMMERCIALLY CANNED FRUITS

Materials.—Cans of each of the different grades of the more important canned fruits, such as cling-stone peaches, free-stone peaches, apricots, pears, cherries, strawberries, blackberries, and olives.

Procedure:

1. Weigh the can.

2. Cut the can and empty the contents on a piece of ⅛-inch mesh screen and drain for at least two minutes. Weigh the drained fruit and measure the volume of syrup. Weigh the empty can. Compare the drained weights with those given in the Appendix, Table XV.

3. Count the number of pieces of all fruits except berries.

4. Determine the Balling degree and temperature of the syrup. By use of Table XIII in the Appendix make the necessary temperature correction. Determine the Baumé degree of the brine from the olives.

5. Determine the acidity of the syrup as directed in Methods of Analysis, page 98. Apples and pears contain malic acid, grapes tartaric acid, and other fruits citric acid. Determine the reaction of the brine from the olives.

6. Carefully note and compare the appearance and flavor of the fruit and syrup for the different grades.

7. Note the appearance of the interior of the can; i. e., whether it shows evidence of excessive corrosion or the accumulation of iron or tin oxide.

8. Determine the grade of each sample by reference to the Specifications for Canned Fruits and Tables I and II.

9. Ascertain the probable concentration of syrup added at the time of canning to the different grades of fruit examined.

Suggestions:

SPECIFICATIONS FOR CALIFORNIA CANNED FRUITS
(Adopted by the Canners' League of California)

General Description of Grades:

Fancy grade or superlative quality consists of fruit of very fine color, ripe yet retaining its form, not mushy, free from blemishes, with the pieces uniform in size and very symmetrical.

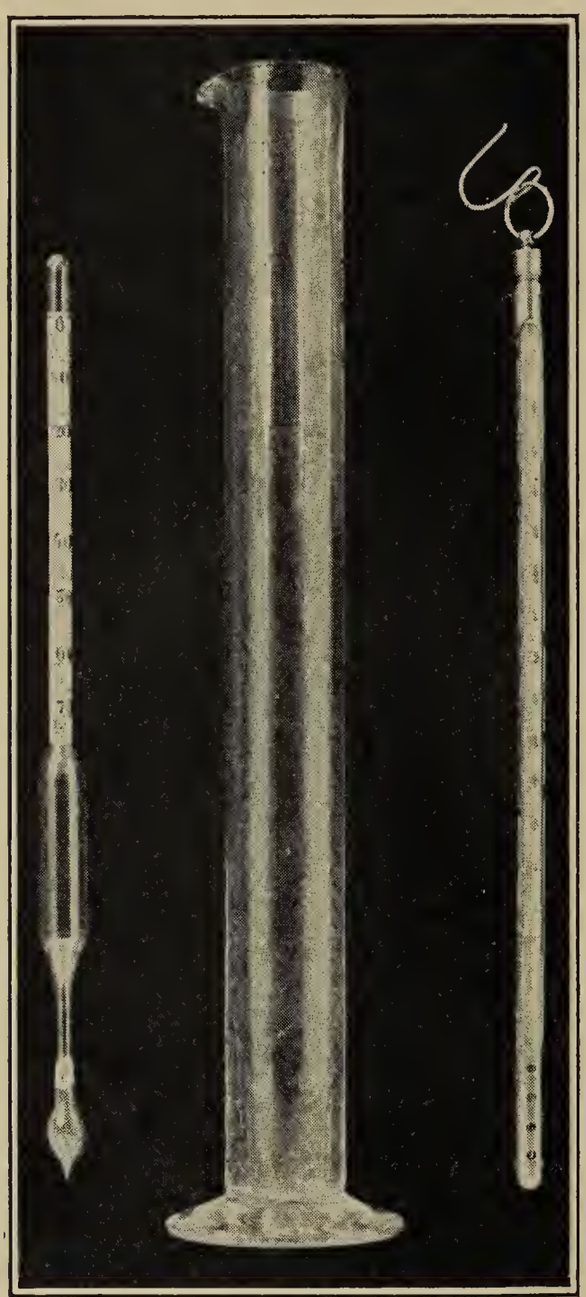

FIG. 1.—Balling hydrometer, cylinder and thermometer.

Choice grade or fine quality consists of fruit of fine color, ripe yet retaining its form, not mushy, free from blemishes, with the pieces uniform in size and symmetrical.

Standard grade or good quality consists of fruit of reasonably good color, ripe yet not mushy, reasonably free from blemishes, with the pieces reasonably uniform in size and reasonably symmetrical.

Second grade or second quality consists of fruit tolerably free from blemishes, pieces tolerably uniform in size, color and ripeness.

Pie grade or pie quality consists of wholesome fruit unsuited for the above grades.

Table I gives the number of pieces per No. 2½ can for the five grades of each fruit and also the percentage of sugar in the syrup placed in the can.

TABLE I.—CONCENTRATION OF SYRUP AND NUMBER OF PIECES PER NO. 2½ CAN FOR CALIFORNIA CANNED FRUITS

Grade	Apricots (Halves)		Pears (Halves)		Peaches (Halves)	
	Pieces per No. 2½ can	Per cent sugar in syrup used	Pieces per No. 2½ can	Per cent sugar in syrup used	Pieces per No. 2½ can	Per cent sugar in syrup used
Fancy...	24 or less	55	6 to 12	40	6 to 12	55
Choice...	30 or less	40	6 to 15	30	6 to 15	40
Standard	42 or less	25	6 to 21	20	6 to 12	25
Second..	No limit	10	No limit	10	No limit	10
Pie.....	No limit	0	No limit	0	No limit	0

Grade	Cherries (Black or White)		Cherries (Royal Anne)		Grapes	Plums
	Pieces per No. 2½ can	Per cent sugar in syrup used	Pieces per No. 2½ can	Per cent sugar in syrup used	Per cent sugar in syrup when canned	Per cent sugar in syrup when canned
Fancy...	Not over 100	40	Not over 85	40	40	55
Choice...	Not over 125	30	Not over 105	30	30	40
Standard	Not over 175	20	Not over 145	20	20	25
Second..	No limit	10	No limit	10	10	10
Pie.....	No limit	0	No limit	0	0	0

Canned Fruit Salad:—

Count:—Contents divisible into portions approximately uniform as to variety.

Syrup:—Not less than 40 per cent. sugar.

Description:—Color of fruit to be good for each variety; ripe, yet not mushy, and free from blemishes serious for the grade; pieces of each variety of fruit to be uniform in size and symmetrical.

Table II gives the relation between the grade of the fruit and the Balling degree of the syrup *after canning*. This is known among canners as the "cut out" test of the syrup.

Table II.—Approximate Concentration of Syrup from Various Grades of Canned Fruit—"Cut Out Test"

(Compiled from U. S. Dept. Agr. Bull. **196** by A. W. Bitting)

Fruit	Fancy Grade Balling Degree	Choice Grade Balling Degree	Standard Grade Balling Degree	Second Grade Balling Degree	Pie Grade Balling Degree
Apricots (Royal)	34	27	20	14	9
Cherries (Black Tartarian)	28	23	18	14	10
Cherries (Royal Anne)	26	22	18	15	10
Grapes (Muscat)	28	24	21	17	12
Peaches	31	22	17	11	9
Pears (Bartlett)	25	21	16	14	11
Plums (Green Gage)	34	27	19	13	9

Table III.—Commercial Size Grades of California Ripe Olives

Grade	*No. per Pound*	*Grade*	*No. per Pound*
Small	120 to 135	Mammoth	65 to 75
Medium	105 to 120	Giant	55 to 65
Large	90 to 105	Jumbo	45 to 55
Extra Large	75 to 90	Colossal	35 to 45

Ripe olives of the best quality should have a uniformly black or dark brown skin. The flesh should be tender, but not soft, light in color, and should not adhere tightly to the pit.

ASSIGNMENT II.—EXAMINATION OF SOUND AND SPOILED CANNED FRUITS AND VEGETABLES

Materials.—One can each of the best and poorest grades of several varieties of canned fruits and vegetables, including tomatoes.

Several spoiled cans of fruits and vegetables. Samples of "flippers," "springers," "swells," "leakers," and "flat sours."

Procedure:

1. *Examination of Sound Samples.*—Determine the vacuum within the can by piercing the top with a vacuum can tester. Open the sound cans of fruits and vegetables and compare the different grades as to appearance, flavor and odor.

Place a drop of syrup or brine from each sample on a microscope slide and cover with a cover glass. Examine carefully under the high power of the microscope (500 or 1,000 diameters magnification) and compare the numbers of organisms found in the liquids from the best and poorest grades of each product. In similar manner mount, examine and compare samples of the pulp.

2. *Examination of Spoiled Samples.*—Compare external appearance and internal pressure of a "flipper," a "springer" and a "swell."

Open the spoiled samples and compare the appearance of each with that of sound samples. Note the odor. *Do not taste spoiled canned food,* because it may contain *Bacillus botulinus* and be poisonous.

Examine the syrup or brine from each sample under the high power of the microscope. Make sketches of the organisms found. Carefully compare the microscopical appearance of the organisms found in the spoiled canned fruits with that of the micro-organisms from the spoiled canned vegetables.

3. *Examination of the can:*

A. By Pumping.—Cut a circular opening in one end of the unopened can of such size that it can be closed later by soldering on a cap. Remove the contents of the can and rinse thoroughly. Boil the can in water about one hour and again rinse and drain. Cans with rubber gaskets should be dried about one hour at 175°F. Paper gasket cans need not be dried. Solder a cap over the opening and through a small hole in this cap admit compressed air. At intervals of 5 pounds pressure submerge the can in water and observe carefully for escaping bubbles. The maxi-

mum pressure to which cans may be subjected without "buckling" depends on the size of the can. Number 10 cans may "buckle" at 10 to 15 pounds, No. 3 cans at 15 to 20 pounds, and No. 2 cans at 30 pounds. Buckling distorts the seams and causes leaks which did not previously exist. The location of leaks should be marked and the can examined to

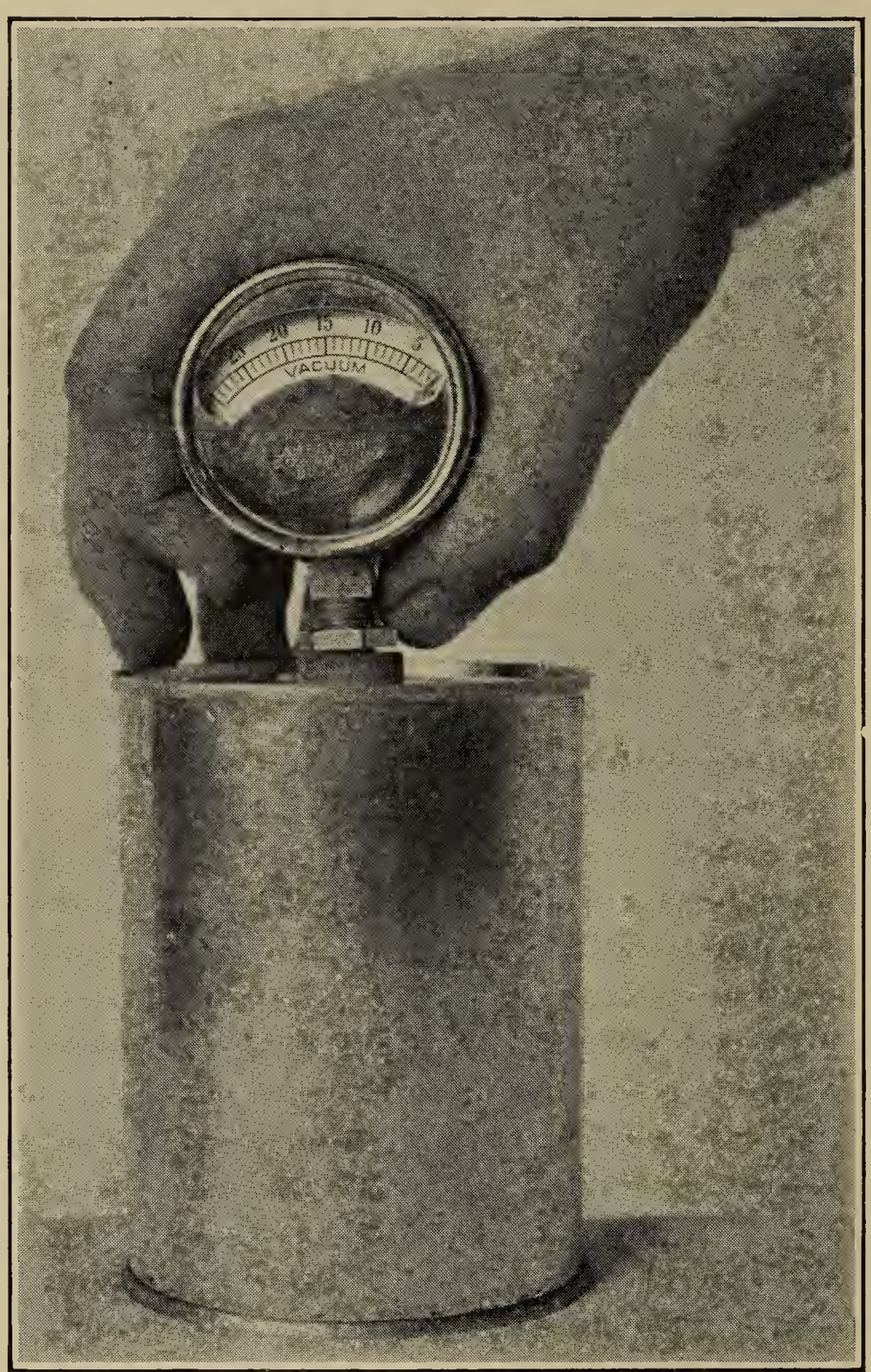

FIG. 2.—Determining vacuum in a can.

ascertain the nature and cause of the leaks. (A special apparatus for "pumping" cans is manufactured by the American Can Company.)

B. By Filing.—File a cross section through the crimped edge of the can a short distance from and on each side of the side seam of the can, using a three-cornered file. File through the outer sheet of tin-plate between the two cross-section cuts and then press the end "hook" out of the seam. This will reveal the condition of the gasket and seam and

indicate if the seam was properly made. Both the "factory" end and the "cannery" end of a can may be examined to locate faulty double seaming. Any seam in the can which showed a leak when tested in *A* above should be examined carefully by filing or in the case of soldered seams by separating the tin plate sheets and noting the continuity of the solder used in sealing.

Suggestions:

1. Definitions.—A "swell" is a can which has undergone gaseous decomposition by micro-organisms which first releases the vacuum and then causes pressure in the can.

A "springer" is a can the ends of which are more or less bulged, owing to the pressure of hydrogen gas generated by chemical action of the acid on the contents of the metal of the container, or because the can has been overfilled or insufficiently exhausted.

A "flipper" is a springer of such mild character that the head of the can may be drawn in by striking the end of the can on a hard surface.

The term "flat sour" may be used to cover many abnormalities in canned foods, but generally to designate a can of food which has undergone bacterial decomposition with increase of acidity but without gas formation. Canned corn occasionally becomes "flat sour."

A "leaker" is a can from which part of the syrup or brine has exuded. Leaks may be caused by external injury, by internal pressure, by corrosion or by faulty sealing. The contents of a "leaker" may or may not be spoiled.

2. Centrifuging.—In order to concentrate the micro-organisms in the syrup or brine from sound samples, a small portion of the liquid may be placed in a centrifuge tube and subjected to centrifugal action for a few minutes. The sediment will contain most of the micro-organisms.

3. Staining.—Yeasts and molds may be examined very satisfactorily without staining. Bacteria may be seen more clearly under the microscope if stained. Place a drop of the liquid on a glass slide. Dry it, without scorching, above a small gas flame. Fix the material by passing the slide quickly through the flame several times. Cover with a drop of carbol fuchsin. Heat above flame until steam is given off. Rinse in running water. Dry above a flame. Examine without the use of a cover glass.

4. Spoilage of canned fruit is usually caused by yeasts which enter the can through leaks after sterilizing and is rarely due to insufficient sterilization. The spoilage of canned vegetables, however, is usually caused by spore-bearing bacteria which survive the temperature of processing.

5. The pie grade of most fruits will normally contain a few yeast cells and an occasional mold filament. The poorer grades of canned tomatoes may exhibit a considerable number of mold filaments and bacteria. The presence of a large number of mold filaments indicates the use of decayed material. Large numbers of yeasts or bacteria in sterile cans of food indicate that swelled cans or "flat sours" have been reprocessed.

ASSIGNMENT III.—EXPERIMENTAL CANNING OF FRUIT

Materials.—About 25 pounds of firm ripe canning peaches, 5 pounds of firm tart apples, and 5 pounds of firm ripe berries.

Procedure:

1. *Comparison of Methods of Peeling Peaches.*—*A.* Peel and pit by hand enough firm, ripe peaches of yellow flesh to fill one can.

B. Halve and pit a similar quantity and place on a screen tray or in a wire basket in live steam for 3 to 4 minutes. Skins of ripe free-stone canning varieties can then be slipped from the fruit.

C. Prepare in an agate-ware pot a lye solution containing 5 grams of sodium hydroxide per 100 c.c. of water. Heat to boiling. Immerse single halves of the unpeeled fruit in the boiling lye 10, 20 and 30 seconds respectively and rinse thoroughly in running water. This will determine the length of immersion required for peeling. Peel enough fruit by this method to fill one can. Remove all trace of lye from the fruit by thorough rinsing. Record the loss in peeling by the three methods. Fill the cans of peeled fruit with syrup of 30° Balling. Exhaust 5 minutes in live steam; seal and sterilize 20 minutes at 212°F. After 48 hours or longer examine the fruit and syrup carefully for flavor and appearance.

2. *Effect of Concentration of Syrup.*—Prepare enough of each of the following syrups to fill one can of peaches: 0° Balling (water), 10°, 20°, 40°, 60° Balling, see Table IV. Prepare enough fruit to fill five cans and weigh both the empty and filled cans. Heat each syrup to boiling; fill into the respective cans and seal. Sterilize for the length of time indicated in Table VI; remove the cans and chill in water. Allow to stand about one week. Determine the weight of drained fruit from each can and the volume and Balling of the syrup. Carefully compare the appearance, texture and flavor of the fruit from the different cans.

3. *Effect of Type of Container on Quality of Canned Fruit.*—Weigh one each of the several types of containers, such as sanitary, solder-top and wax-top cans and glass jars. Fill each with peaches and weigh. Prepare a syrup of 30° Balling. Heat this to boiling and fill the glass jars to overflowing and the cans to within about a quarter of an inch of the top. Exhaust the solder-top and sanitary cans in live steam for 5 minutes before sealing. Sterilize, store and examine as in Assignment III C 2.

A. Sealing Solder-Top Cans. *Caution.*—Do not fill the cans above one-quarter inch below the cap.

(*a*) Wipe the groove dry of all syrup and juice.

(*b*) Apply the cap and wipe the groove and edge of the cap with a small brush dipped in soldering fluid.

(*c*) Dip a hot well-tinned soldering steel momentarily in soldering fluid, apply to the can and melt a little solder in the groove.

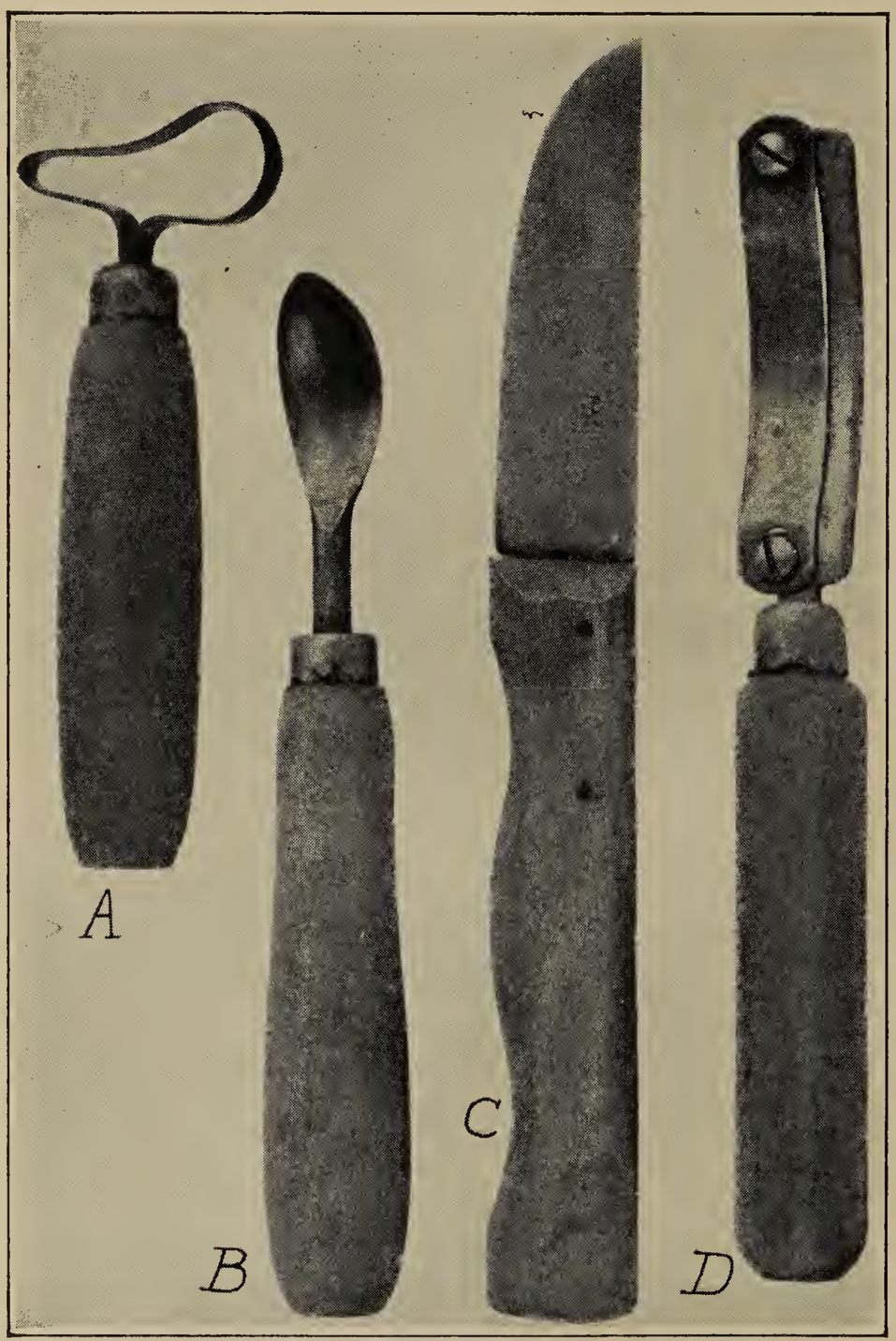

FIG. 3.—A, Coring knife; B, Pitting spoon; C, Cutting knife, and D, Peeling knife.

(*d*) Revolve the hot steel to distribute the solder evenly.

(*e*) Press down on the center rod, and raise the steel a few seconds to permit the solder to harden.

(*f*) After exhausting the can wipe the vent hole and seal with a drop of solder applied with a well-tinned tipping steel. See Fig. 4.

B. Sealing a Sanitary Can.—(*a*) Place the lid on the can and set

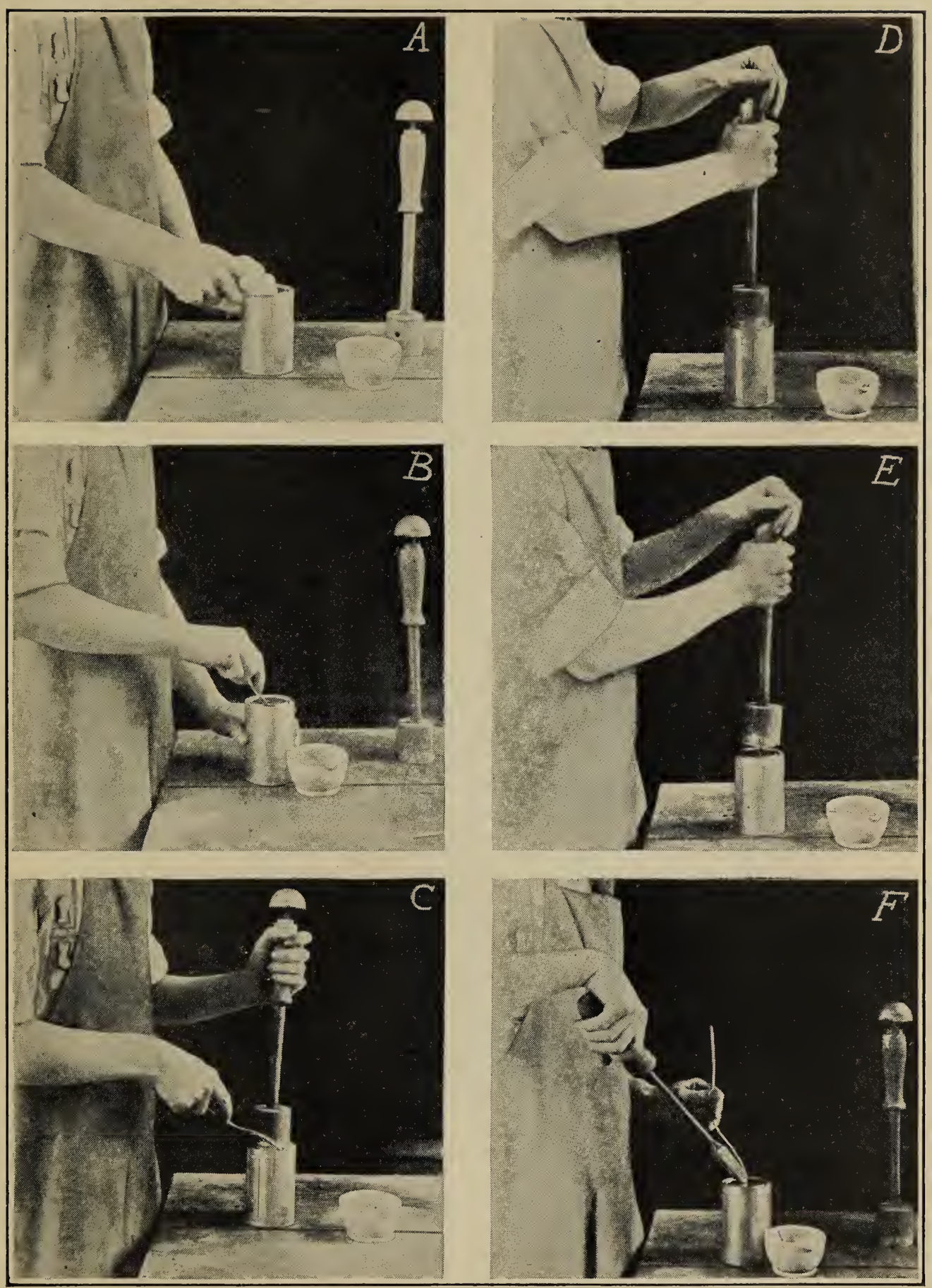

FIG. 4.—Sealing a solder top can; A. Wiping the groove; B. Applying soldering fluid; C. Melting solder in groove; D. Sealing on cap; E. Allowing solder to harden; F. Soldering vent hole (tipping).

the can on the turn table. Raise the turn table, by swinging the raising lever slowly *toward the operator* until it will go no farther. Give the

(*b*) Turn the crank rapidly and at the same time push the seaming roll lever very slowly *away from the operator* to bring roll Number 1 against the top of the can until it will go in no farther.

(*c*) Continue turning the crank rapidly and pull the seaming roll lever slowly *toward the operator* until it will go no farther. Give the crank several more turns and remove the sealed can. See Figs. 5 and 6.

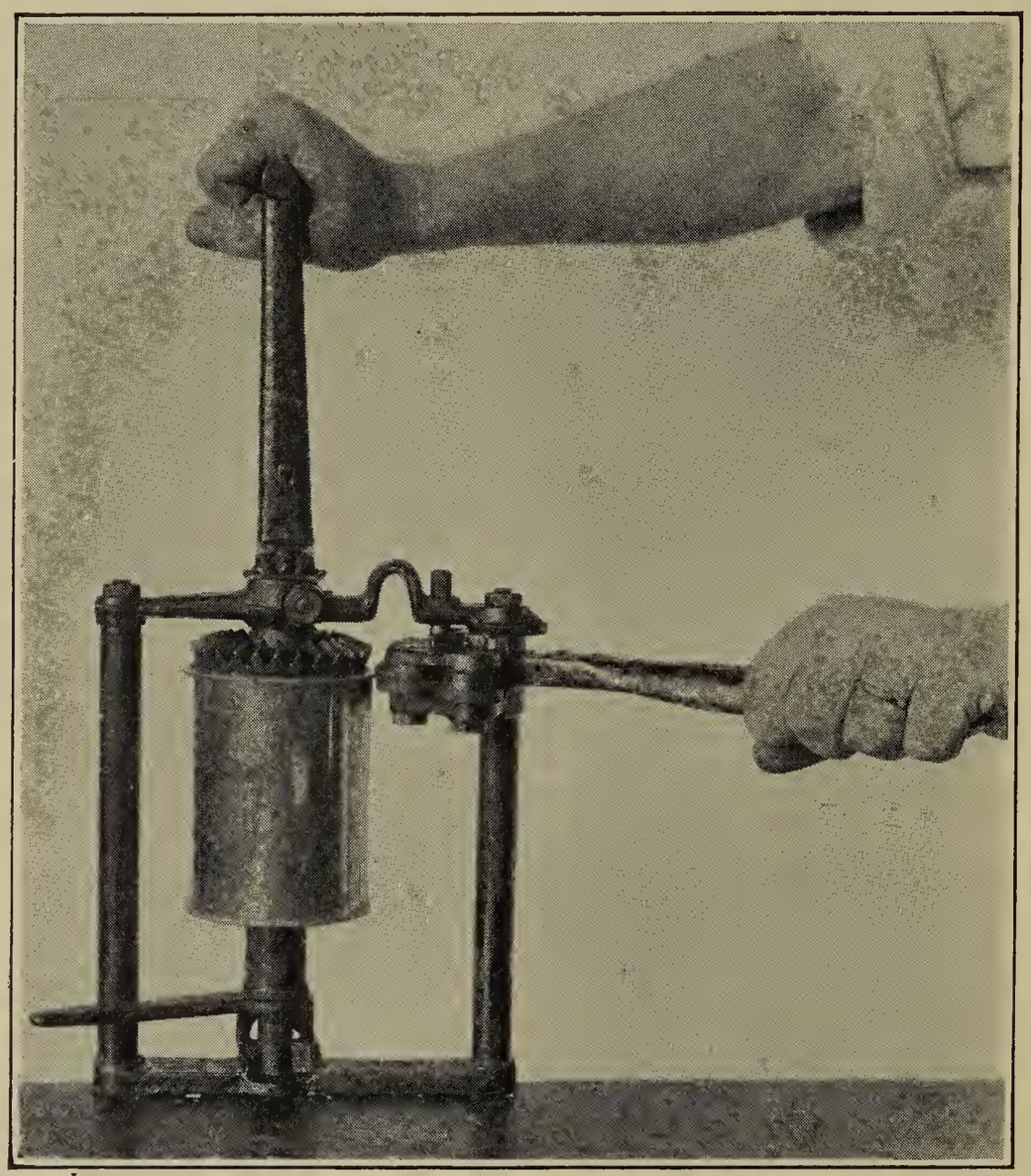

Fig. 5.—Hand power sealer for sanitary cans.

C. Place the covers on the wax top cans, but do not seal with wax until after sterilization.

D. Place rubber rings and covers on the glass jars, but do not seal tightly until after sterilization.

4. *Effect of Kind of Sugar.*—Prepare syrups of 30° Balling from several kinds of syrup, such as highest quality of glucose syrup, refined malt syrup, sorghum syrup, and as controls, 30° Balling syrups from cane sugar and beet sugar. Fruit juices may also be used instead of

syrup. Can peaches in these syrups, sterilize, store, and examine as directed under Paragraph 2.

5. *Effect of Temperature.*—Prepare four cans of peaches, weighing the fruit placed in each can. Add a boiling 20° Balling syrup and seal. Heat at the following temperatures for the times indicated:

165°F. for 30 minutes
185°F. for 25 minutes
212°F. for 20 minutes
230°F. for 15 minutes (under pressure)

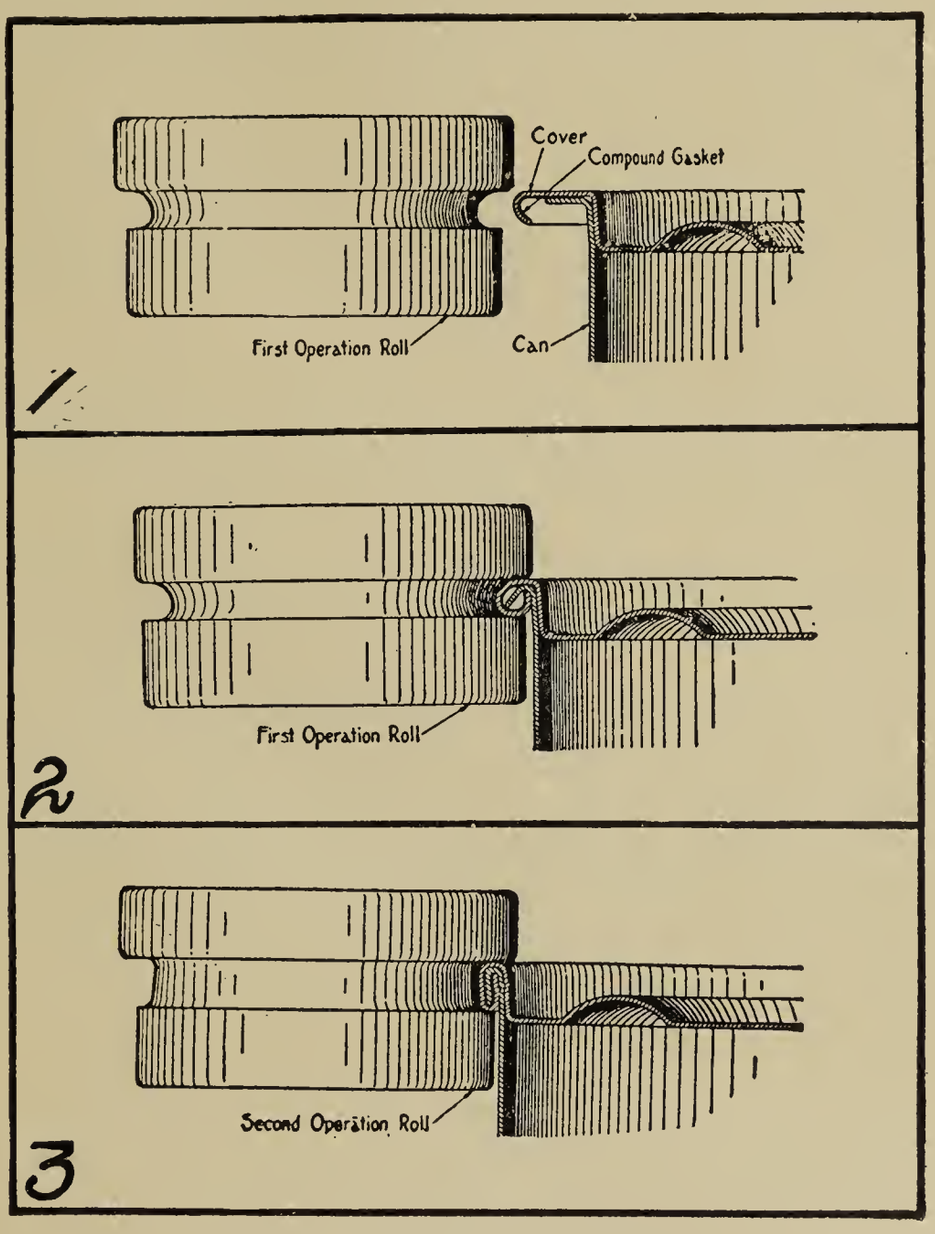

Fig. 6.—Sealing a sanitary can.

Cool, store and examine as in Paragraph 2. If blackberries, strawberries or raspberries are available, repeat the above tests with one of these fruits.

6. *Effect of Exhausting.*—Fill three cans with peeled, cored and quartered apples and add cold water to fill the cans to ¼ inch from the top. Seal Can No. 1. Heat Can No. 2 in water at 180°F. for 6 minutes and

seal. Heat Can No. 3 in boiling water 6 minutes and seal. Sterilize the three cans for the time given in Table VI. Store the cans for 2 weeks and examine carefully as follows:

Determine the vacuum in each can by means of a vacuum can tester. Open the cans and compare the amount of corrosion of the tin in each, especially at the water line near the top of the can. Compare the three samples as to appearance, flavor and texture.

Suggestions:

1. If apples are used the peelings and cores should be weighed, dried, again weighed, and the product retained for subsequent use in jellies or preserves. Pits should be weighed, dried and retained for the preparation of sweet and bitter almond oils.

2. When several syrups of different strengths are required it is convenient to make a sufficient quantity of 60 per cent. syrup and then dilute portions of this to the required strengths in accordance with the proportions given in Table IV.

TABLE IV.—PREPARATION OF SYRUPS FOR CANNING

To make 5 gallons of 60 per cent syrup take 32 lbs., 3 oz. (14.6 Kilograms) of sugar and 2 gals., 2 qts. and ½ pt. (9754 cubic centimeters) of water.

896 c.c. 60 per cent syrup plus 105 c.c. water gives 1,000 c.c. 55 per cent syrup
796 c.c. 60 per cent syrup plus 205 c.c. water gives 1,000 c.c. 50 per cent syrup
701 c.c. 60 per cent syrup plus 301 c.c. water gives 1,000 c.c. 45 per cent syrup
609 c.c. 60 per cent syrup plus 393 c.c. water gives 1,000 c.c. 40 per cent syrup
522 c.c. 60 per cent syrup plus 480 c.c. water gives 1,000 c.c. 35 per cent syrup
438 c.c. 60 per cent syrup plus 564 c.c. water gives 1,000 c.c. 30 per cent syrup
357 c.c. 60 per cent syrup plus 645 c.c. water gives 1,000 c.c. 25 per cent syrup
280 c.c. 60 per cent syrup plus 722 c.c. water gives 1,000 c.c. 20 per cent syrup
206 c.c. 60 per cent syrup plus 796 c.c. water gives 1,000 c.c. 15 per cent syrup
134 c.c. 60 per cent syrup plus 866 c.c. water gives 1,000 c.c. 10 per cent syrup

ASSIGNMENT IV.—PRACTICE IN FRUIT CANNING

Materials.—At least five pounds each of firm ripe fruits such as apples, apricots, plums, cherries, pears and berries.

Procedure:

1. *Preparation.*—Weigh the fresh fruit and prepare for canning as follows:

Apples: Peel and core by mechanical peeler. Trim and quarter by hand. Hold in 3 per cent. brine to prevent darkening.

Apricots: Cut in half and remove pit. Make a clean cut on line of suture. Do not break or tear edges of halves.

Berries: Sort out defective berries, stems and leaves. Stem strawberries.

Cherries: Remove stems. If desired, pits may be removed by small hand pitting machine.

Grapes: Remove all stems and defective berries.

Peaches: Halve and pit as for apricots. Peel as described in Assignment III.

Pears: Hand peel, halve, core and stem. Hold in 3 per cent. brine to prevent darkening.

Plums: Remove stems and defective fruits.

Weigh the prepared fruit in each case and calculate the percentage loss in preparation. Wash all prepared fruit thoroughly.

2. *Grading:*

A. Quality: Sort the fruit according to quality to conform as nearly as possible to the five grades given in Table I.

B. Size: Peaches, apricots, cherries, grapes and plums are graded for size by a series of vibrating screens, containing circular openings of the average sizes given in Table V. Because of their shape pears are graded by hand. If a mechanical grader is not available, grading may be accomplished by use of a board containing holes of the proper diameter.

3. *Filling and Syruping.*—Fill the cans with fruit and add the proper degree of syrup for each grade as specified in Table I.

4. *Exhausting and Sealing.*—Exhaust the filled cans in live steam or boiling water for 5 minutes. Seal the cans immediately after exhausting.

5. *Sterilizing and Cooling.*—Sterilize the cans in accordance with the time periods given in Table VI. Chill the cans in cold water and store for future examination.

6. *Examination.*—After one week or longer open the cans and examine as directed in Assignment I. Compare the results with the data given in Tables I and II.

Suggestions.—Apricot and cherry pits should be air-dried, weighed and retained for the preparation of fruit kernel oils in Assignment XXVI.

TABLE V.—AVERAGE DIAMETERS OF VARIOUS GRADES OF CANNED FRUITS

(Thirty-Seconds of an Inch)

Fruit	Fancy	Choice	Stand.	Fruit	Fancy	Choice	Stand.
Apricots	56/32	54/32	50/32	Peaches	76/32	64/32	56/32
Cherries, Royal Anne	29/32	28/32	22/32	Plums, Green Gage	56/32	50/32	42/32
Cherries, Black	26/32	25/32	22/32	Pears, Bartlett	8–10*	10–12*	15–17*
Grapes, Muscat	26/32	25/32	24/32				

* Number per No. 2½ Can.

TABLE VI.—APPROXIMATE TIME REQUIRED FOR STERILIZATION OF FRUITS AT 212° F

Fruit	No. 1 Tall Cans	No. 2½, No. 3 and Wax Top Cans	No. 10 Cans	Quart Glass Jars
	Minutes	*Minutes*	*Minutes*	*Minutes*
Apples	10	10	15	20
Apricots	8	15	25	20
Blackberries	8	12	25	20
Cherries	15	20	30	30
Currants	8	12	25	20
Figs	60	60	70	75
Gooseberries	8	12	25	20
Grapes	8	10	25	20
Loganberries	8	12	25	20
Oranges	8	10	25	15
Peaches (soft)	15	20	40	25
Peaches (firm)	20	25	40	30
Pears	20	25	40	30
Plums	10	14	25	20
Prunes (fresh)	10	12	25	20
Raspberries	8	12	25	20
Rhubarb	8	12	25	20
Strawberries	8	12	25	20

ASSIGNMENT V.—DETERMINATION OF THE GRADE OF COMMERCIALLY CANNED VEGETABLES

Materials.—One can each of the different grades of several important vegetables, such as tomatoes, corn, peas, string beans and asparagus.

Procedure:

1. Weigh the can.
2. Ascertain the vacuum within the can by piercing the top of the can with a vacuum can tester.
3. Open the can and empty the contents on a piece of ⅛-inch mesh screen and drain for 2 minutes. Weigh the drained vegetable and measure the volume of brine. Weigh the empty can. Compare the drained weights with those given in the Appendix, Table XV.
4. In asparagus, count the number of spears; in peas or beans, ascertain the average diameter of the pieces.
5. Compare the different grades of each vegetable for (*a*) color, (*b*) odor, (*c*) condition of pieces; that is, whether whole or broken; prime, over-mature or immature; soft or firm; (*d*) flavor.
6. Note the clearness, color and general appearance of the brine. Determine its specific gravity or Baumé degree. If desired, the amount of salt in the brine may be determined as outlined on page 98 of Appendix. Where a sugar brine has been used the concentration of sugar may be determined as described on page 100 of Appendix.
7. Note the condition of the interior of the can.

Suggestions.—The commercial grades of canned vegetables are not as well standardized as those of canned fruits. The following specifications describe the most common commercial grades and form a guide in determining the grade of the samples examined.

Grades of Canned Vegetables

Corn:

A. Styles:

1. Maine style—thick and creamy consistency without separation of liquid. (Can not be labelled "Maine Style" unless canned in Maine.)
2. Maryland style—whole grains in clear brine.

B. Grades:

1. Fancy—young, tender, no tough grains, medium moist, free from silk, cob or husk. Flavor of young corn. Only slightly darker than natural product.

2. Extra Standard—corn with some slight defect, but better than standard grade as described below.

3. Standard—reasonably tender, only slightly brown in color, nearly free from silk, cob or husk. Only slight "cooked taste."

4. Second—hard, tough grains of poor flavor or appearance.

Peas:

A. Varieties:

1. Early Peas—small, smooth, round.

2. Sweet Peas—wrinkled, irregular in shape, later maturing, distinctly sweet.

B. Size Grades:

No.	Common Name	Diameter in Inches
1	Petit Pois	Below 9/32
2	Extra Sifted	9/32 to 10/32
3	Sifted	10/32 to 11/32
4	Early June	11/32 to 12/32
5	Marrowfat	12/32 to 13/32
6	Telephone	Over 13/32

C. Quality Grades:

1. Fancy—young, succulent, fairly uniform in size and color, reasonably clear liquor, no flavor defects.

2. Standard—less succulent, green, mellow consistency, uniform in size and color, reasonably clear liquor, fairly free from flavor defects.

3. Seconds—over-mature, not fully ripened or lacking in other respects the qualifications of standard peas.

Beans (string, green or wax):

A. Size Grades:

No. 1, less than 12/64 inch diameter	Packed whole
No. 2, 12/64 to 14/64 inch diameter	
No. 3, 14/64 to 17/64 inch diameter	Cut beans
No. 4, 17/64 to 20/64 inch	
No. 5, over 20/64 inch	

B. Quality Grades:

1. Fancy—prime beans, uniform and tender in quality, good flavor and color, carefully handled and canned, clear brine.

2. Extra Standard—not equal to fancy grade because of a slight defect.

3. Standard—good field run beans of less uniform selection. May be slightly discolored or broken.

4. Seconds—wholesome beans which may be coarse, tough, poorly stringed or with foreign flavor.

Tomatoes:

A. Types:

1. Solid Pack Tomatoes—peeled and cored tomatoes canned whole or in large pieces without addition of any liquid.

2. Tomatoes in Puree—peeled and cored tomatoes, generally smaller pieces to which has been added puree made from whole tomatoes or from trimmings of tomatoes.

B. Grades:

1. Extra Fancy—ripe fruit of uniform red color, well-developed flavor and fleshy body. Mostly whole tomatoes free from peel, cores or defects.

2. Extra Standard—ripe fruit of fairly fleshy body, good flavor and few yellow or green pieces. Mostly large pieces, well peeled, cored and trimmed.

3. Standard Tomatoes—fully matured, sound fruit of fair body and flavor. Broken pieces of irregular color, but well peeled, cored and trimmed.

4. Seconds—a mixture of green, immature pieces and soft, over-ripe tomatoes.

Asparagus:

California asparagus is graded by hand according to the number of spears per can. Each size grade is further graded into white and green asparagus.

Grade	Size of Can	No. Spears per Can
Giant	2½, Square*	8 to 12
Colossal	2½, Square	13 to 16
Mammoth	2½, Square	17 to 24
Mammoth	1, Square—Tips*	21 to 30
Large	2½, Square	25 to 34
Large	1, Square—Tips	31 to 40
Medium	2½, Square	35 to 44
Medium	1, Square—Tips	41 to 60
Small	2½, Square	45 to 60
Small	1, Square—Tips	61 to 80
Tiny	1, Square—Tips	81 to 100

* No. 1, Square Can is 3×3½×3½ inches; No. 2½, Square Can is 3×3½×6¼ inches.

Beets:

Beets should be tender and without large vascular zones and of a uniform deep red color throughout.

1. Small—below 1 inch diameter.
2. Medium.—1 to 1½ inches diameter.
3. Large—1½ to 2 inches diameter.
4. Very large—over 2 inches diameter (cut beets).

ASSIGNMENT VI.—EXPERIMENTAL CANNING OF VEGETABLES

Materials.—A vegetable of high acidity, such as tomatoes or rhubarb, and a vegetable of low acidity, such as string beans, peas, or corn.

Procedure:

1. *Preparation.*—Prepare the raw material for canning as directed in Assignment VII.

2. *Effect of Composition of Vegetables on Sterilizing Temperature.*—Prepare three cans each of an acid vegetable (e. g., tomatoes) and of a vegetable of low acidity. Exhaust the cans in hot water at 175°F. for about 6 minutes; seal hot. Heat one can of each in water at 175° to 180°F. for 30 minutes; one can of each in boiling water for 30 minutes and one can of each at 240°F. for 15 minutes. Remove the cans in each instance and chill in water. Place the cans in an incubator at 90° to 100°F. for 2 weeks and note the condition of the cans and contents.

3. *Effect of Composition of Brine.*—Prepare six cans of a vegetable of low acidity, such as peas or string beans. Fill Can No. 1 with boiling 2 per cent. brine; No. 2 with boiling 4 per cent. brine; No. 3 with a boiling 6 per cent. brine; No. 4 with 2 per cent. brine acidified to 0.1 per cent. acidity with lemon juice or citric acid; No. 5 with 2 per cent. brine acidified to 0.2 per cent. citric acid; and No. 6 with 2 per cent. brine acidified to 0.15 per cent. acetic acid with distilled vinegar. (See page 98 in Appendix for determination of acid.) Exhaust all the cans for 5 minutes and seal hot. Heat all the cans in boiling water for 30 minutes. Remove and cool in water. Incubate all the cans at 90° to 100°F. for 2 weeks and examine.

4. *Critical Temperature.*—Prepare five cans each of tomatoes and string beans; add 2 per cent. brine to the string beans; exhaust all the cans for 5 minutes and seal. Heat the cans for 1 hour as follows: One can at 212°F.; one can at 240°F.; one can at 250°F. Cool all the cans in water. After 48 hours compare the quality of the different lots in respect to texture, color, odor and flavor.

5. *Intermittent Sterilization.*—Prepare 8 cans of a vegetable of low acidity in 2 per cent. brine. Add spore-bearing cultures of *Bacillus subtilis* or other harmless spore-bearing bacteria. Exhaust 5 minutes and seal. Place two cans in cold water and heat to boiling. Boil one hour. Similarly, boil two cans 1½ hours. Similarly, heat two cans in

water until the water boils and boil for 30 minutes each of 2 successive days. Similarly, heat two cans for 30 minutes on each of three successive days. Place all cans in an incubator at 90° to 100°F. for 2 weeks and then examine.

Caution.—Spoiled cans of vegetables may be poisonous and must not be tasted.

Suggestions.—The presence of thermophilic bacteria which have survived the process of sterilization can be ascertained by incubating cans at 130°F. for two weeks. The cans will become "flat sours" if thermophilic bacteria have been active.

ASSIGNMENT VII.—PRACTICE IN VEGETABLE CANNING

Materials.—At least five pounds each of such vegetables as corn, peas, pumpkin, sweet potatoes, asparagus and spinach.

Procedure:

1. *Preparation.*—Prepare the vegetables as directed below, and determine the loss in preparation.

Asparagus.—Cut to proper length for containers.

Corn.—Carefully remove all husk and silk as well as worm-eaten portions. Cut kernels from cob with a sharp, thin-bladed knife and scrape cobs.

Beans (Green, String or Wax).—Snip the ends of beans and remove strings.

Beets.—Cut off leaves, retaining 1 inch of stems. Do not cut off roots. Heat in retort at 220°F. for 20 to 25 minutes, or in boiling water. Remove stems, roots and skins.

Peas.—Shell from pods.

Peppers or Pimientos.—Place in a wire basket and dip in a kettle of boiling cottonseed oil (about 400°F.) until peel separates, about 1 to 4 minutes. Wash and cool in water. Strip off loosened peel, cut out stem and scoop out core and seeds, carefully preserving the flesh in one piece.

Pumpkin.—Wash thoroughly; remove stems; chop into large pieces; place in pans in a retort at 240°F. for 20 minutes. Separate pulp from skins, seeds and fiber by rubbing through a fine screen. Concentrate to a thick consistency in a steam-jacketed kettle. The specific gravity should be about 1.06 to 1.08.

Potatoes, Sweet.—Heat in a retort at 240°F. for 9 to 12 minutes. Slip the skins off by hand.

Spinach.—Cut off crowns, heavy stalks and yellow leaves. Wash very thoroughly to remove adhering soil.

Tomatoes.—Remove decayed portions. Wash thoroughly. Heat in boiling water or steam about one minute. Chill in cold water. Remove peels and cores.

2. *Grading.*—Grade asparagus, beans, beets and peas for size and quality by reference to Assignment V.

3. *Blanching and Pre-cooking.*—Blanch asparagus, string beans, peas and spinach in boiling water as directed in Table VII. The time of blanching is regulated by the size and maturity of the product. Thorough washing should always follow blanching.

Corn.—Add to the cut corn a sweet brine containing about 4 per cent. sugar and 2.5 per cent. salt, at the rate of 5 ounces per No. 2 can. Mix thoroughly and cook in a steam-jacketed kettle until tender and the liquid and the kernels no longer separate.

4. *Filling and Brining.*—Corn, pumpkin and sweet potatoes: The cans should be filled with the hot vegetables without addition of brine. Pimientos and peppers are packed solidly and may be canned with or without brine. Other vegetables may be placed in the cans cold and the cans filled with hot brine of the composition given in Table VII.

Use lacquered cans for beets, pumpkin and sweet potatoes.

5. *Exhausting and Sealing.*—Exhaust the filled cans in live steam for the periods given in Table VII. Seal immediately after exhausting.

6. *Sterilization and Cooling.*—Sterilize the hot sealed cans at the temperatures and times given in Table VII. Cool thoroughly in water immediately after sterilizing. The sterilizing periods and temperatures given in Table VII vary with the maturity of the products and size of the can. The periods given are for non-agitating sterilizers.

7. *Storage and Examination.*—Store for about two weeks and compare the quality with that of samples of similar commercial canned products.

TABLE VII.—CANNING SCHEDULE FOR VEGETABLES

Vegetable	Steaming or Blanching		Composition of Brine		Exhausting	Sterilizing No. 2 or No. 3 Cans	
	Temp.	Minutes	Per cent Salt	Per cent Sugar	Minutes at 212°	Temp.	Minutes
Asparagus	212°	3– 5	2	.....	8–12	233°	30
Beans, string	212°	1– 9	1½–2½	.....	5– 6	240°	30
Beets	220°	20	0–2½	.....	5– 6	245°	60
Corn	.....	.....	2–½	4	.....	250°	75
Peas	212°	3–15	2	0–3	6–11	240°	40
Peppers or Pimientos	400°*	1– 4	0 or 2	.....	3–13	212°	35
Potatoes, Sweet	240°	9–12	.....	.....	12–18	212°	180
Pumpkin	240°	20	.....	.....	.....	250°	90
Spinach	212°	3– 6	3–½	.....	8–11	252°	50
Tomatoes	212°	½–1	.....	.....	8–10	212°	30

*Cottonseed Oil.

TABLE VIII.—RELATION OF STEAM PRESSURE TO TEMPERATURE

Pressure-Pounds per Square Inch	Temperature, ° Fahrenheit	Pressure-Pounds per Square Inch	Temperature, ° Fahrenheit
1	215.2	9	236.6
2	218.3	10	238.8
3	221.3	11	241.0
4	224.2	12	243.1
5	226.9	13	245.3
6	229.5	14	247.3
7	231.9	15	249.1
8	234.3	16	250.7

ASSIGNMENT VIII.—EXAMINATION OF TOMATO PRODUCTS

Materials.—Samples of tomato puree, paste and catsup.

Procedure:

1. *Determination of Total Solids.*—*A.* Official Method: Place from 2 to 4 grams of the well-mixed sample in an accurately weighed flat-bottomed dish about 2½ inches in diameter, spreading thinly. Accurately weigh the dish and sample. Place in a vacuum oven at 70°C. (158°F.) for 4 hours in a vacuum equivalent to 28 to 29 inches mercury. Remove from the oven and weigh immediately. The loss in weight divided by the weight of sample multiplied by 100 gives the percentage of water in the sample, which subtracted from 100 gives the percentage of total solids.

B. Tentative Method: In the absence of a vacuum oven, weigh 10 grams of the well-mixed sample into a weighed flat-bottom dish Evaporate to dryness on a steam bath and dry 4 hours in a water- or steam-jacketed oven at 95° to 100°C. (203° to 212°F.). The percentage of total solids thus obtained should be multiplied by the factor 1.085 to give the true percentage.

2. *Determination of Specific Gravity.*—*A.* By Pycnometer: Weigh a dry and empty 50-c.c. pycnometer. Fill with distilled water at 20°C. and weigh. The difference between these two weights gives the volume of the pycnometer or *A*. Empty the pycnometer and weigh. Add about 10 grams of well-mixed sample and weigh. The difference between these two weights gives the exact weight of the sample or *B*. Fill with distilled water at 20°C., weigh and subtract the original weight of the dry pycnometer. Call this *C*. *C* minus $B = D$, the volume of water required to fill the pycnometer after addition of the sample. *A* minus *D* gives *E*, the volume of water displaced by the sample. *B* divided by *E* gives the specific gravity of the sample.

B. By Hydrometer: Fluid samples such as light puree can be filtered through cloth or filter paper and the specific gravity of the clear filtrate obtained by means of a specific gravity hydrometer at 20°C. By reference to Table IX the specific gravity of the original sample may be obtained.

3. *Relation of Total Solids to Specific Gravity.*—Table IX gives the

relation between the specific gravity of tomato puree, the specific gravity of the filtrate and total solids. The table does not apply to tomato catsup or other products to which foreign materials have been added.

4. *Microscopical Examination.—A.* Estimation of Molds: Fit the microscope with a 10X (1 inch) eye piece and 16-mm. (2/3 inch) objective. Place a stage micrometer under the objective and adjust the draw tube until the field of vision is 1.4 mm. in diameter. This equals an area of 1.5 square mm. The larger divisions on the stage micrometer are 0.1 mm. and the smaller divisions .01 mm. apart. If a stage micrometer is

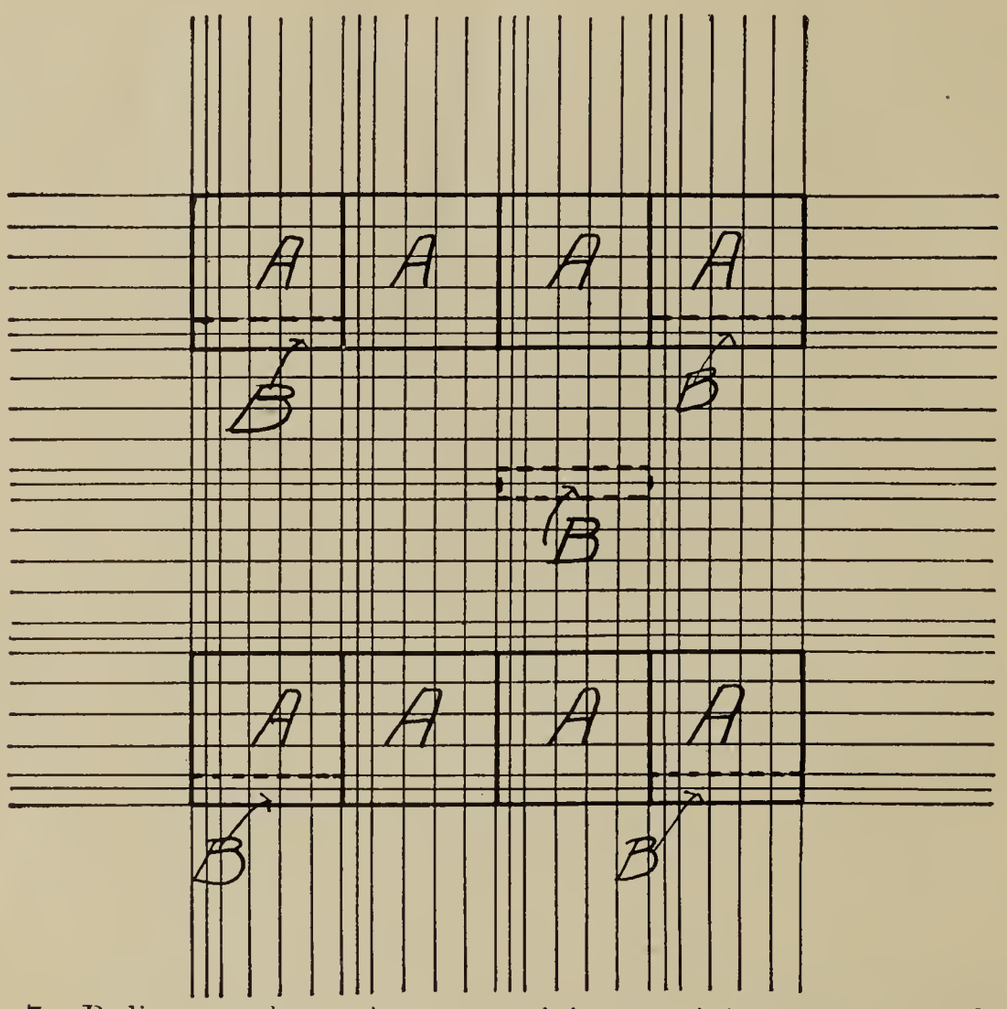

FIG. 7.—Rulings on hæmetimeter used in examining tomato products.

not available a hæmetimeter may be used to measure the diameter of the field. Each small square of the hæmetimeter is 0.05 mm. in diameter. The magnification should be 90 to 100 diameters.

Spread a drop of the well-mixed sample on the disc of a Howard counting chamber. Cover with the heavy cover-glass and press it evenly against the slide. This forms a layer of material one millimeter thick.

Examine carefully 50 separate fields for mold filaments. This will usually require two mountings. All fields showing mold filaments aggregating one-sixth or more of the diameter of the field are considered positive. Multiply the number of positive fields by 2 to obtain "Percentage of Fields Showing Mold." In the examination of tomato paste

dilute the sample in the proportion of 2 c.c. of water to each gram of paste.

B. Yeasts and Spores: Fit the microscope with a 10X (1 inch) eye piece and an 8-mm. (1/3 inch) objective. This gives a magnification of about 200 diameters, draw tube set at 160 mm.

Dilute 10 c.c. of puree or catsup to 30 c.c. with water or paste 10 grams to 90 c.c. Mix thoroughly and allow to settle a few minutes. Mount a drop of the settled liquid on the disc of a hæmetimeter. Cover with a large cover-glass and press evenly against the slide.

Count the number of mold spores and yeast cells in 200 of the small squares of the hæmetimeter represented by eight blocks of 25 squares each marked *A* in Fig. 7.

Each of the smallest squares is .05 mm. x .05 mm., or .0025 square mm. in area. Since the liquid is 0.1 mm. in depth the volume of liquid above each square is .00025 cubic mm. Therefore the volume above 200 squares is .00025 x 200 = .05 cubic mm. or 1/20 cu. mm. Since the sample was diluted to one-third its original concentration, the above estimation represents the number of "Yeasts and Spores per 1/60 cu. mm."

C. Bacteria (Howard Method): Fit the microscope with a 12.5X eye piece and 4-mm. (1/6 inch) objective. This combination gives a magnification of 570 at draw tube setting of 160 mm.

Use the same mounting as for yeasts and spores. Count the number of distinct rod-shaped bacteria in 25 small squares; i. e., five groups of five small squares each represented by letter B in Fig. 7. Do not count spherical forms. Mount two more samples and repeat the examination and determine the average number of bacteria to the small square.

Since one small square represents .00025—i. e., 1/4,000 cubic millimeters of liquid—one bacterium to a square represents 4,000 per cu. mm., or 4,000,000 per cubic centimeter. Since the sample was diluted to one-third its original concentration, one bacterium to a square represents 12,000,000 bacteria per cubic centimeter of original sample.

D. Bacteria (Miller Modification): Transfer 20 c.c. of the sample to a 100-c.c. beaker; add 2 c.c. Loeffler's methylene blue stain; boil 3 minutes; add 2 c.c. Ziehl-Nielsen carbol-fuchsin stain; boil 3 minutes; allow to cool slightly; add 3 to 4 drops of formalin; make up to 60 c.c. with water; mix and allow to settle. Examine as in Assignment VIII 4 C. The staining renders the bacteria more clearly visible.

Suggestions:

1. Tomato products which, upon microscopic examination by the above methods, show 66 per cent. or more positive mold fields, or yeast and spores in excess of 125 per 1/60 cu. mm. or bacteria in excess of 100,000,000 per c.c., are subject to seizure and condemnation under the

TABLE IX.—RELATION BETWEEN TOTAL SOLIDS AND SPECIFIC GRAVITY OF TOMATO PULP AND FILTRATE*

Per cent Solids in Pulp	Specific Gravity at 20° C.		Per cent Solids in Pulp	Specific Gravity at 20° C.		Per cent Solids in Pulp	Specific Gravity at 20° C.	
	Pulp	Filtrate		Pulp	Filtrate		Pulp	Filtrate
3.42	1.0150	1.0133	5.38	1.0228	1.0209	7.34	1.0308	1.0285
3.47	1.0152	1.0136	5.44	1.0230	1.0211	7.40	1.0310	1.0287
3.53	1.0155	1.0138	5.49	1.0233	1.0213	7.45	1.0313	1.0290
3.58	1.0157	1.0140	5.55	1.0235	1.0216	7.51	1.0315	1.0292
3.64	1.0159	1.0142	5.60	1.0237	1.0218	7.56	1.0317	1.0294
3.70	1.0161	1.0144	5.66	1.0240	1.0220	7.62	1.0320	1.0296
3.76	1.0163	1.0146	5.72	1.0242	1.0223	7.68	1.0322	1.0298
3.81	1.0166	1.0149	5.77	1.0244	1.0225	7.74	1.0324	1.0300
3.87	1.0168	1.0151	5.83	1.0247	1.0227	7.79	1.0326	1.0303
3.92	1.0170	1.0153	5.88	1.0249	1.0229	7.85	1.0329	1.0305
3.98	1.0172	1.0155	5.94	1.0251	1.0231	7.90	1.0331	1.0307
4.03	1.0174	1.0157	6.00	1.0253	1.0233	7.96	1.0333	1.0309
4.09	1.0177	1.0160	6.05	1.0256	1.0235	8.02	1.0336	1.0311
4.15	1.0179	1.0162	6.11	1.0258	1.0238	8.07	1.0338	1.0313
4.20	1.0181	1.0164	6.16	1.0260	1.0240	8.12	1.0340	1.0315
4.26	1.0183	1.0166	6.22	1.0263	1.0242	8.18	1.0342	1.0318
4.31	1.0185	1.0168	6.28	1.0265	1.0244	8.24	1.0345	1.0320
4.37	1.0188	1.0170	6.33	1.0267	1.0246	8.30	1.0347	1.0322
4.43	1.0190	1.0173	6.39	1.0270	1.0249	8.35	1.0349	1.0324
4.48	1.0192	1.0175	6.45	1.0272	1.0251	8.40	1.0352	1.0326
4.54	1.0194	1.0177	6.50	1.0274	1.0253	8.46	1.0354	1.0328
4.59	1.0197	1.0179	6.56	1.0276	1.0255	8.52	1.0356	1.0331
4.65	1.0199	1.0181	6.61	1.0279	1.0257	8.57	1.0358	1.0333
4.71	1.0201	1.0183	6.67	1.0281	1.0259	8.63	1.0361	1.0335
4.76	1.0203	1.0185	6.72	1.0283	1.0261	8.68	1.0363	1.0337
4.82	1.0205	1.0188	6.78	1.0285	1.0263	8.74	1.0365	1.0339
4.87	1.0208	1.0190	6.84	1.0288	1.0266	8.80	1.0367	1.0341
4.93	1.0210	1.0192	6.89	1.0290	1.0268	8.86	1.0370	1.0344
4.99	1.0212	1.0194	6.95	1.0292	1.0270	8.91	1.0372	1.0346
5.04	1.0215	1.0196	7.01	1.0294	1.0272	8.96	1.0374	1.0348
5.10	1.0217	1.0198	7.06	1.0297	1.0274	9.02	1.0277	1.0350
5.16	1.0219	1.0200	7.12	1.0299	1.0277	9.08	1.0379	1.0352
5.21	1.0222	1.0203	7.17	1.0301	1.0279	9.14	1.0381	1.0354
5.27	1.0224	1.0205	7.23	1.0304	1.0281	9.19	1.0383	1.0357
5.33	1.0226	1.0207	7.28	1.0306	1.0283	9.25	1.0386	1.0359

*According to Bigelow and Fitzgerald in *Journal of Industrial and Engineering Chemistry*, vol. 7, No. 7, page 602. July, 1915.

TABLE IX.—Continued

Per cent Solids in Pulp	Specific Gravity at 20° C.		Per cent Solids in Pulp	Specific Gravity at 20° C.		Per cent Solids in Pulp	Specific Gravity at 20° C.	
	Pulp	Filtrate		Pulp	Filtrate		Pulp	Filtrate
9.30	1.0388	1.0361	10.97	1.0456	1.0426	12.65	1.0524	1.0491
9.36	1.0390	1.0363	11.02	1.0458	1.0428	12.71	1.0526	1.0493
9.42	1.0393	1.0366	11.08	1.0461	1.0430	12.77	1.0528	1.0495
9.47	1.0395	1.0368	11.14	1.0463	1.0433	12.83	1.0531	1.0498
9.53	1.0397	1.0370	11.20	1.0465	1.0435	12.88	1.0533	1.0500
9.58	1.0400	1.0372	11.25	1.0467	1.0437	12.94	1.0535	1.0502
9.64	1.0402	1.0374	11.30	1.0469	1.0439	12.99	1.0538	1.0504
9.70	1.0404	1.0376	11.36	1.0472	1.0441	13.05	1.0540	1.0506
9.75	1.0406	1.0379	11.41	1.0474	1.0444	13.10	1.0542	1.0508
9.80	1.0408	1.0381	11.47	1.0476	1.0446	13.16	1.0544	1.0511
9.86	1.0410	1.0383	11.53	1.0478	1.0448	13.22	1.0547	1.0513
9.92	1.0413	1.0385	11.59	1.0481	1.0450	13.27	1.0549	1.0515
9.97	1.0415	1.0387	11.64	1.0483	1.0452	13.32	1.0551	1.0517
10.02	1.0417	1.0389	11.70	1.0485	1.0454	13.38	1.0554	1.0519
10.08	1.0419	1.0392	11.75	1.0487	1.0457	13.44	1.0556	1.0521
10.14	1.0421	1.0394	11.81	1.0490	1.0459	13.50	1.0558	1.0523
10.19	1.0424	1.0396	11.87	1.0492	1.0461	13.55	1.0560	1.0525
10.25	1.0426	1.0398	11.93	1.0494	1.0463	13.60	1.0562	1.0527
10.30	1.0428	1.0400	11.99	1.0496	1.0465	13.66	1.0565	1.0529
10.35	1.0430	1.0402	12.05	1.0499	1.0467	13.72	1.0567	1.0531
10.41	1.0433	1.0404	12.10	1.0501	1.0469	13.78	1.0569	1.0533
10.47	1.0435	1.0406	12.15	1.0503	1.0471	13.83	1.0572	1.0535
10.52	1.0437	1.0409	12.21	1.0505	1.0474	13.89	1.0574	1.0537
10.58	1.0440	1.0411	12.26	1.0508	1.0476	13.95	1.0576	1.0539
10.64	1.0442	1.0413	12.32	1.0510	1.0478	14.01	1.0579	1.0241
10.70	1.0444	1.0415	12.37	1.0512	1.0480			
10.75	1.0447	1.0417	12.43	1.0515	1.0482			
10.80	1.0449	1.0419	12.49	1.0517	1.0484			
10.86	1.0451	1.0422	12.55	1.0519	1.0487			
10.91	1.0453	1.0424	12.60	1.0522	1.0489			

Federal Pure Foods and Drugs Act of 1906. The same standards have been adopted by most states.

Investigations have shown that with reasonable care and promptness in the sorting and washing of tomatoes, together with cleanliness in the care of equipment, it is readily possible to manufacture tomato products containing numbers of micro-organisms well below the legal limits.

For a more detailed discussion of this subject consult U. S. Dept. Agr. Bull. 581.

2. No legal standards for the specific gravity of tomato products have been adopted, but the following tentative standards have been suggested and are generally observed in commercial practice:

Light tomato puree, 6.3 per cent. total solids = 1.026 spec. gravity.

Medium tomato puree, 8.37 per cent. total solids = 1.035 spec. gravity.

Heavy tomato puree, 12.00 per cent. total solids = 1.050 spec. gravity.

Tomato catsup, not less than 12 per cent. tomato solids.

3. *Benzoate of Soda.*—Thin catsups low in acetic acid are sometimes preserved with sodium benzoate, which is permitted by the Food and Drug Regulations if the presence of benzoate is declared on the label. The usual quantity is 0.1 per cent. The presence of this preservative can be detected by the method given in the Appendix, page 102.

ASSIGNMENT IX.—EXPERIMENTAL PREPARATION OF TOMATO PUREE

Materials.—About 50 pounds of field run tomatoes with at least one-third of the tomatoes showing mold.

Procedure:

1. Carefully separate the sound tomatoes from those showing mold. Wash the sound tomatoes. Crush and pulp these tomatoes without heating and divide the screened pulp into two portions. Concentrate one portion at once to a specific gravity of about 1.035 as directed in Section 1, Assignment X. Allow the other portion to stand for one day or overnight and then concentrate in the same way.

2. Rinse but do not trim the moldy tomatoes and prepare from them puree of about 1.035 specific gravity as described in Section 1, Assignment X.

3. Determine the amounts of mold and of bacteria in the three lots of puree as described in Assignment VIII. Compare the results obtained with the character of the raw material and the methods of handling.

Suggestions.—Save the tomato seeds as directed in Suggestions, Assignment X.

ASSIGNMENT X.—PRACTICE IN THE PREPARATION OF TOMATO PRODUCTS

Materials.—Approximately 250 pounds of sound, smooth, evenly-ripened tomatoes of deep-red color, firm flesh and good flavor.

Procedure:

1. *Medium Puree.*—Weigh accurately; sort carefully; trim and wash about 50 pounds of tomatoes. Determine the loss in trimming.

Crush the tomatoes thoroughly and transfer to a steam-jacketed kettle or large aluminum pot and boil about three minutes.

Pass the hot pulp through the finishing screen of a tomato pulper or rub through a very fine copper screen by hand to remove the seeds, skins and fiber.

Return the pulp to the kettle or large pot and concentrate rapidly with constant stirring to a specific gravity of 1.035, determined as directed below. This specific gravity corresponds approximately to a concentration of 3 parts of raw pulp to 2 parts of puree.

Rapid Determination of Specific Gravity

Filter a sample of the hot pulp through cheese cloth into a hydrometer cylinder packed in crushed ice and salt. Cool the filtrate rapidly to 20°C. (68°F.) and determine the specific gravity by means of an accurate hydrometer or Westphal balance. Obtain the corresponding specific gravity of the puree from Table IX.

Determine the volume of finished puree. Fill several 16-oz. bottles, plain sanitary cans and lacquered cans with the boiling-hot puree. Seal all containers immediately and invert, using crown caps for the bottles. Heat two of the plain cans in boiling water or steam for 30 minutes. Store all samples for subsequent examination.

2. *Puree for Catsup.*—Treat a carefully weighed quantity of tomatoes (about 50 pounds) as directed in Assignment X 1, but concentrate to a specific gravity of 1.060. Determine the yield by volume and by weight.

Reserve one gallon of the concentrated puree for the preparation of catsup in Assignment X 3. Fill one-half of the remainder boiling hot into lacquered cans and one-half boiling hot into plain tin cans; seal at once; invert to cool and set aside for at least six weeks. Compare these sam-

ples with those prepared according to Assignment X 1 for color, flavor and consistency.

3. *Tomato Catsup* (Spiced Vinegar Process).—To 435 c.c. of distilled vinegar of 10 per cent. acetic acid content ("100 grain" vinegar) and 132 c.c. of water in a 1,000-c.c. flask add the following ingredients:

Onions, peeled and chopped	105 grams	Allspice, whole	4.5 grams
Garlic, peeled and chopped	1 gram	Cayenne pepper, ground	1 gram
Cloves, whole	4 grams	Mace, not ground	1 gram
Cinnamon, whole	7 grams		

Connect the flask to a reflux condensor or cover the mouth of the flask with a watch glass or Petri dish and allow to simmer for about one hour. Strain through cheese cloth. If the volume is less than 570 c.c. add water to restore to this volume. Dissolve in this hot spiced vinegar 585 grams of sugar and 135 grams of salt. Add this spiced vinegar to one gallon (3,785 c.c.) of puree of about 1.060 specific gravity. Stir thoroughly, heat to boiling and fill hot into 16-oz. crown-finish bottles. Seal at once and invert to cool. Heat two of the bottles in boiling water or steam for 30 minutes.

Note the flavor, color, odor and consistency after six weeks' storage. A specific gravity determination may be made if desired.

4. *Tomato Catsup* (by Direct Extraction of Spices).—Place in a small cheese-cloth bag the same quantities of spices, onion and garlic as used in Paragraph 3. Tie the mouth of the bag and place it in three gallons of unconcentrated raw tomato pulp. Concentrate by boiling to about 1.060 specific gravity (approximately one gallon). Dissolve 585 grams of sugar and 135 grams of salt in 435 c.c. of distilled vinegar (100 grain) and 132 c.c. water. Add this solution to the concentrated hot puree. Stir thoroughly, heat to boiling, remove the sack of spices and fill the catsup hot into 16-oz. crown-finish bottles. Determine the approximate yield. Store and examine as under Assignment X 3.

5. *Chili Sauce.*—To 380 c.c. of distilled vinegar (100 grain) in 1,000 c.c. flask add the following ingredients:

Onions, chopped	363 grams
Allspice, whole	5.6 grams
Cloves, whole	5.6 grams
Cinnamon, sticks	6.6 grams

and allow to simmer for about one hour as in Assignment X 3, and strain through cheese cloth. Dissolve in the strained liquid 636 grams sugar and 136 grams of salt.

Place 8,400 grams whole peeled tomatoes in a pot and concentrate to approximately 4,000 c.c. Then add 5.6 grams ground cayenne pepper and 1.4 grams ground mustard. Concentrate to about 3,400 c.c. and add

the spiced vinegar. Stir thoroughly. Heat to boiling and seal hot in glass fruit-jars. Pasteurize 40 minutes in water at 185°F. Store and examine as under Assignment X 3.

6. *Hot Sauce* (Spanish Style).—To 6,205 c.c. of raw non-concentrated pulp (from a tomato pulper) add the following ingredients, finely ground:

Onions	74	grams
Ground chili peppers	112	grams
Garlic	2.3	grams

Concentrate to about 3,785 c.c. Add 2.5 grams ground cayenne pepper mixed with about 10 c.c. of water, and 74 grams of salt. Stir thoroughly. Heat to boiling and fill boiling hot into small cans. Seal, store and examine as under Assignment X 3.

Suggestions.—The skins and seeds separated from the tomato pulp should be collected and weighed, after which this material should be dried at a moderate temperature in a dehydrater or over a radiator, weighed again and the skins separated from the seeds by fanning. The dry, clean seed should be retained for the preparation of tomato-seed oil as directed in Assignment XXVI.

ASSIGNMENT XI.—EXAMINATION OF COMMERCIAL FRUIT JUICES

Materials.—One bottle each of the juice of the following: Eastern grape, California grape, loganberry, pineapple, orange, apple and lemon. One can of pure apple juice and a sample of apple juice preserved with benzoate of soda.

Procedure:

1. *Appearance.*—Before opening a bottle note whether the juice is brilliant, clear, hazy, cloudy or muddy; whether there is a small, medium or large amount of sediment and whether this deposit is amorphous or crystalline. Describe the color of the juice.

2. *Net Contents.*—Determine the volume of juice in each container and report as fluid ounces. Compare with the net contents declared on the label.

3. *Flavor and Odor.*—Note the odor of the juice, especially in regard to the presence or absence of fresh-fruit aroma or of "cooked" odor. Note whether the flavor is fresh, stale or "cooked." Note whether the acid and sugar are agreeably balanced. Compare the flavor of apple juice containing benzoate of soda with that of juice free from this preservative.

4. *Balling Degree.*—Determine the Balling degree by means of a Balling hydrometer and record the temperature. Also determine the concentration by a Baumé hydrometer and by an accurate specific-gravity hydrometer or Westphal balance. Convert Baumé and specific-gravity readings to the corresponding Balling degree by means of Table XIV. Correct all readings for temperature by means of Table XIII.

If desired, cane sugar and invert sugar may be determined by the methods given in the Appendix, page 100.

5. *Acid.*—By means of a pipette measure 10 c.c. of the sample into a 500-c.c. flask. (With lemon juice dilute 10 c.c. to exactly 100 c.c., mix and take 10 c.c. of diluted juice for titration.) To light-colored juices add about 100 c.c. and to dark-colored juices about 300 c.c. of recently distilled water and a few drops of phenolphthalein indicator. Titrate as directed on page 98 of Appendix and express as grams of citric acid per 100 c.c. of juice for citrus, pineapple and berry juices; as of tartaric acid for grape juice; and as of malic acid for apple juice. If the sample is carbonated, heat to boiling 10 c.c. of juice diluted with distilled water before titration.

Suggestions:

1. Compare the quality and the composition of the commercial juices with the fresh juices prepared in Assignment XIII.

2. Carbonated beverages (bottled soda waters) prepared either from pure fruit juices, pure fruit syrups, or artificially flavored and colored syrups may be examined in a similar manner. The presence of sodium benzoate and coal-tar colors may be tested qualitatively as directed in the Appendix, page 102. The pressure of carbon dioxide may be determined by shaking the unopened bottle vigorously and piercing the crown cap with a pressure gauge equipped with a sharp-pointed connection, similar to a vacuum can-tester.

ASSIGNMENT XII.—EXPERIMENTAL PREPARATION OF FRUIT JUICES

Materials.—Fifty pounds of sound, ripe, tart apples or grapes.

Procedure:

1. *Effect of Temperature of Pasteurization on Quality and on Prescnce of Organisms.*—Extract the juice from the fruit as directed in Assignment XIII. To 800 c.c. of juice add several loopfuls each of active yeast and of ordinary green mold (*Penicillium glaucum*) spores. Mix thoroughly. Fill five 4- or 8-ounce bottles and seal with crown caps. Place one bottle in a horizontal position in a pot and cover completely with cold water. Place in the pot another bottle containing water into which is inserted a thermometer through a rubber stopper. Heat slowly until the thermometer registers 55°C. Maintain this temperature 20 minutes and remove the bottle of juice. In a similar way heat bottle No. 2 to 60°C. for 20 minutes; No. 3 to 70°C. for 20 minutes; No. 4 to 80°C. for 20 minutes; and No. 5 in boiling water for 20 minutes. Store all samples 4 weeks and examine for flavor and evidences of spoilage Repeat this series, using carbonated juice (see Assignment XII 2).

2. *Effect of Carbon Dioxide on Temperature of Pasteurization.*—If carbonating equipment is available, carbonate to 50 pounds gas-pressure enough juice, inoculated with yeast and mold as in Paragraph 1, to fill four bottles. Cap at once and heat one bottle at each of the temperatures used in Paragraph 1 for 20 minutes. Omit the boiling-water test. Store 4 weeks and compare with the samples from Assignment XII 1.

If a carbonating machine is not available place about 1,000 c.c. of the juice in a large bottle and cool to about 0°C. (32°F.) by placing the bottle in crushed ice. Pass a slow stream of carbon dioxide from a Kipp generator or cylinder of carbon dioxide into the juice for 20 minutes, stirring occasionally. Bottle, cap and proceed as above.

3. *Caps as a Source of Mold.*—Wrap 5 crown caps in paper and heat in a steam sterilizer at 212°F. for 1 hour.

Fill ten 4-ounce bottles with juice and plug with cotton. Heat in a steam sterilizer for one hour at 212°F. Allow to cool.

Flame the necks of the bottles and cap five bottles with sterile caps, using every precaution possible against infection of the cork discs. Cap the remaining five bottles with untreated caps.

Place the bottles in a pot of cold water and heat to 60°C. (140°F.)

for 15 minutes. Store for 8 weeks and examine for evidence of mold growth.

4. *Bottles as a Source of Mold.*—Plug five 4-ounce bottles with cotton and sterilize one hour in a steam sterilizer at 212°F. Cool.

Sterilize 1,500 c.c. of juice in a large bottle plugged with cotton at 212°F. in a steam sterilizer. Cool. Sterilize 10 caps as directed in Paragraph 3.

Flame the necks of the sterile bottles and of the bottle of juice. Fill the five sterile bottles with sterile juice and seal with sterile caps.

Fill five rinsed but not sterile bottles with sterile juice and seal with sterile caps.

Pasteurize, store and examine as in Assignment XII 3.

5. *Effect of Temperature and Infusorial Earth on Filtration.*—Place 100 c.c. of juice in a folded filter paper in a funnel and measure the volume of juice which filters through in five minutes.

To 100 c.c. of juice add 3 grams of a finely ground infusorial earth, such as "Filter-cel." Mix thoroughly and determine the rate of filtration as above. Compare the clearness with that of untreated filtered juice.

Heat 100 c.c of juice to 165°F. with 3 grams of Filter-cel and determine the rate of filtration and clearness. Note effect, if any, of the Filter-cel on the flavor.

6. *Clarification with Finings.*—Allow 3,000 c.c. of fresh juice to stand overnight. Separate from the sediment by siphoning or decantation.

A. Egg Albumen.—Prepare 100 c.c. of a 2 per cent. solution of dried egg albumen in water by shaking the finely ground albumen in warm water (not above 110°F.). To 100 c.c. portions of the settled juice in 4-oz. bottles add enough of the albumen solution to be equivalent to additions of 0, 25, 50, 100 and 200 grams per hectoliter (100 liters) of juice. Cap the bottles and mix contents thoroughly by shaking. Heat to 165°F. for 20 minutes. Shake and set aside for 24 hours. Note results. If any of the bottles are clear, decant off the clear juice, filter, bottle, and pasteurize at 165°F. Store and compare later with untreated pasteurized juice for clearness and flavor.

B. Casein.—To 2 grams of casein add 2 c.c. concentrated ammonia and 50 c.c. of water. Boil until there is no longer any odor of ammonia. Dilute to 100 c.c. and use this casein solution to repeat clarifying tests as directed for egg albumen above.

C. Spanish Clay.—To 20 grams of finely ground Spanish clay in a mortar add 50 c.c. of water. Grind to a smooth paste. Add 50 c.c. more of water and repeat grinding. Dilute to 200 c.c.

Repeat the clarifying tests as directed for egg albumen, but use the clay suspension at the rate of 200, 500, 1,000 and 1,500 grams (dry weight) of clay per hectoliter. The addition of one c.c. of the 10 per

cent. clay suspension per 100 c.c. of juice corresponds to 100 grams of clay per hectoliter.

7. *Comparison of Glass and Tin Containers.*—Fill one plain No. 2 tin and one No. 2 lacquered can (completely) with juice, using berry or red grape juice if available. Heat in a water bath to 165°F. and seal at once. Fill one No. 2 plain tin can and one bottle with the same juice and seal without heating. Pasteurize the cans and bottle of juice in water at 165°F. for 30 minutes. Store one month and compare quality of juices and effects on container.

8. *Solubility of Metals in Fruit Juice.*—Weigh to one-tenth of a milligram clean dry pieces of iron, tin, aluminum, copper, zinc, silver, nickel and monel metal of approximately the same surface area. Place in individual beakers containing 100 c.c. of juice and boil slowly for 30 minutes. Remove the metals, wash and dry thoroughly and weigh. Note the comparative losses in weight and calculate the loss in milligrams per square centimeter.

ASSIGNMENT XIII.—PRACTICE IN THE PREPARATION OF FRUIT JUICES

Materials.—Five to ten pounds each of the following fruits in season: Apples, grapes, oranges, lemons, pomegranates, and loganberries or blackberries.

Procedure:

1. *Preparation.*—Remove all unsound fruit and weigh. Wash thoroughly. Cut citrus fruits in half. Separate the arals of pomegranates from the peel and "rag" and determine the yield of arals.

2. *Crushing.*—Crush thoroughly all fruits except citrus fruit.

3. *Heating.*—Heat crushed berries and red grapes in a jelly kettle or aluminum pot to 160°F. with constant stirring. Other fruits are not heated before pressing.

4. *Extraction of Juice.*—Enclose the crushed fruits in heavy cloths and press in a small hand-press or under hydraulic pressure. Stir the pressed fruit and subject it to a second pressing. It is customary to place the crushed fruit in coarsely woven press-cloths between wooden racks and to subject it to a pressure of about 400 pounds per square inch for at least 30 minutes.

Extract the pulp and juice from halved citrus fruits by means of a glass cone or a rotating bronze or aluminum cone. Strain the juice through cheese cloth to separate the coarse pulp. Measure the volume of juice obtained from each fruit and weigh the pomace. Determine the Balling degree and acidity of juice.

From Table XIV obtain the corresponding specific gravity of the juice and calculate the yield of juice by weight. Calculate the yield of juice in percentage and in gallons per ton of fresh fruit.

5. *Clearing.*—Citrus juices should be bottled while cloudy. Other juices should be clear.

Set the freshly expressed juice aside in a cool place for 24 hours. Separate from the sediment. Heat to 165°F. Cool. Filter, using a small amount (1 to 3 per cent.) of infusorial earth if necessary.

6. *Bottling or Canning.*—Put the juice into clean bottles, filling to within about 1 inch of the top, and seal with crown caps.

Fill one plain tin can with apple juice and one lacquered can with a red fruit juice. Exhaust to 165°F. and seal.

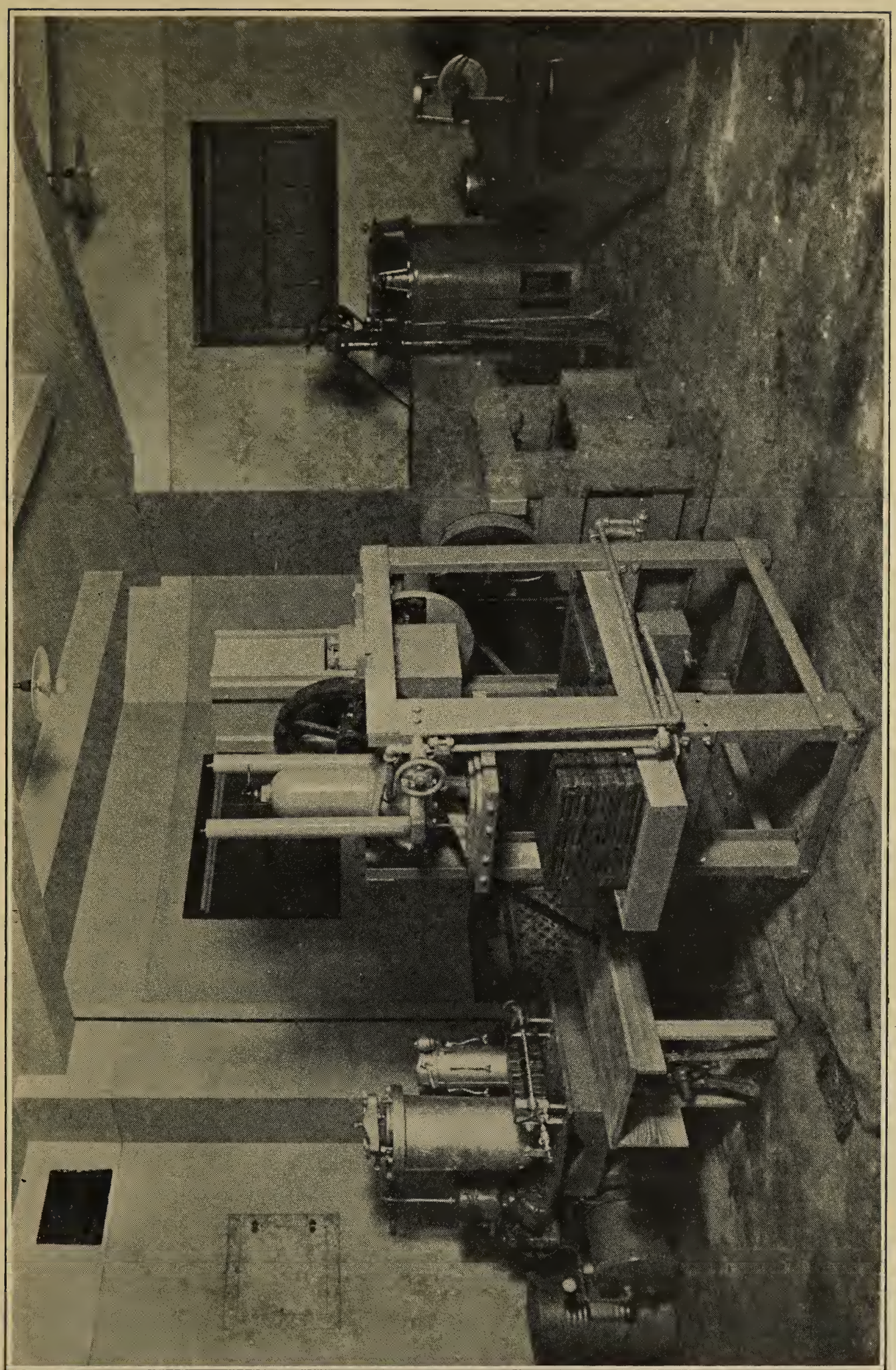

FIG. 8.—View in Fruit Products Laboratory, University of California (fruit crusher and press in foreground).

7. *Pasteurizing.*—Pasteurize 30 minutes at 165°F. Chill cans in cold water. Store bottles in a cool, dark place.

Suggestions:

1. *Utilization of Pomace.—A.* Jelly Stock: The pomace of fruits rich in pectin (such as apples, grapes and sour berries) may be utilized for jelly stock. To extract the pectin mix the pomace with about twice its weight of water and boil about ten minutes. Citrus fruits require 40 minutes. Press out the extract and strain it through a jelly bag. Measure the volume obtained and determine its Balling degree and acidity. Pasteurize in lacquered cans or bottles for future use.

B. Dried Pomace.—The pomace may also be dried and the yield of dry material determined. The pectin of dried pomace from apples and other jelly fruits may be extracted for jelly making.

C. Value for Syrup or Vinegar.—From the yield and composition of the juice obtained in the preparation of jelly stock can be determined the value of the pomace as a source of syrup or vinegar.

ASSIGNMENT XIV.—PREPARATION OF FRUIT SYRUPS

Materials.—Apples or grapes, 100 pounds. Strawberries or other berries, 15 pounds. Samples of commercial fruit syrups.

Procedure:

1. Weigh the apples or grapes carefully and extract the juice as directed in Assignment XIII. Heat to 165°F. and allow to settle. Filter. Determine the Balling degree, specific gravity and acid.

2. *Concentration in Vacuo.*—Place a measured volume of the filtered juice in a small steam-jacketed vacuum pan. Concentrate rapidly to 65° Balling, corrected to 20°C. (68°F.), using highest vacuum attainable, preferably not less than 28 inches of mercury. Measure the volume of the syrup.

Bottle or can in lacquered cans and pasteurize at 165°F. for 30 minutes.

If a steam-jacketed vacuum pan is not available the juice may be concentrated in a heavy-walled flask immersed in a pot of water at 175° to 180°F. and connected through a water-cooled condenser to a vacuum pump. The flask should also be equipped with a vacuum gauge and thermometer. See Fig. 9.

Note the temperature, vacuum and time required to concentrate the juice.

3. *Concentration in Open Pan.*—Place a measured volume of the filtered juice in a steam-jacketed kettle. Concentrate rapidly to 65° Balling, corrected to 20°C. (68°F.). Record concentration and note time required.

If a steam-jacketed kettle is not available concentrate the juice in an aluminum or agate-ware kettle over a flame.

Pasteurize in bottles or in lacquered cans as directed in Assignment XIV 2.

4. *Concentration to Prevent Spoiling.*—Concentrate about 2,000 c.c. of juice to 75° Balling, corrected to 20°C. (68°F.). Dilute small portions to 70°, 65° and 60° Balling, respectively. Place each sample in a bottle and add a loopful of yeast and mold spores to each. Cork the bottles and store for several weeks at room temperature. Examine to determine concentration necessary to prevent spoiling.

5. *Neutralized Syrup.*—Add to a measured quantity of filtered juice sufficient precipitated chalk (calcium carbonate) to reduce the acidity of the final syrup to 0.4 grs. per 100 c.c. The expected yield of syrup may be calculated from the data obtained in Assignment XIV 2 or by

formula No. 1 on page 45. The quantity of calcium carbonate required may be obtained by formula No. 2 on page 45. Boil the juice and calcium carbonate about one minute. Set aside overnight. Filter. Concentrate to 65° Balling, determine the yield and pasteurize as in Assignment XIV 2.

6. *Decolorized Syrup.*—To a measured quantity of juice add enough precipitated chalk (calcium carbonate) to neutralize the acid completely. Add 3 per cent. by weight of finely ground bone-black or 1 per cent. of Eponit, Noirit or other finely ground vegetable decolorizing carbon. Stir. Heat to boiling. Filter. Concentrate *in vacuo* to 65° Balling; determine the yield and pasteurize as directed in Assignment XIV 2.

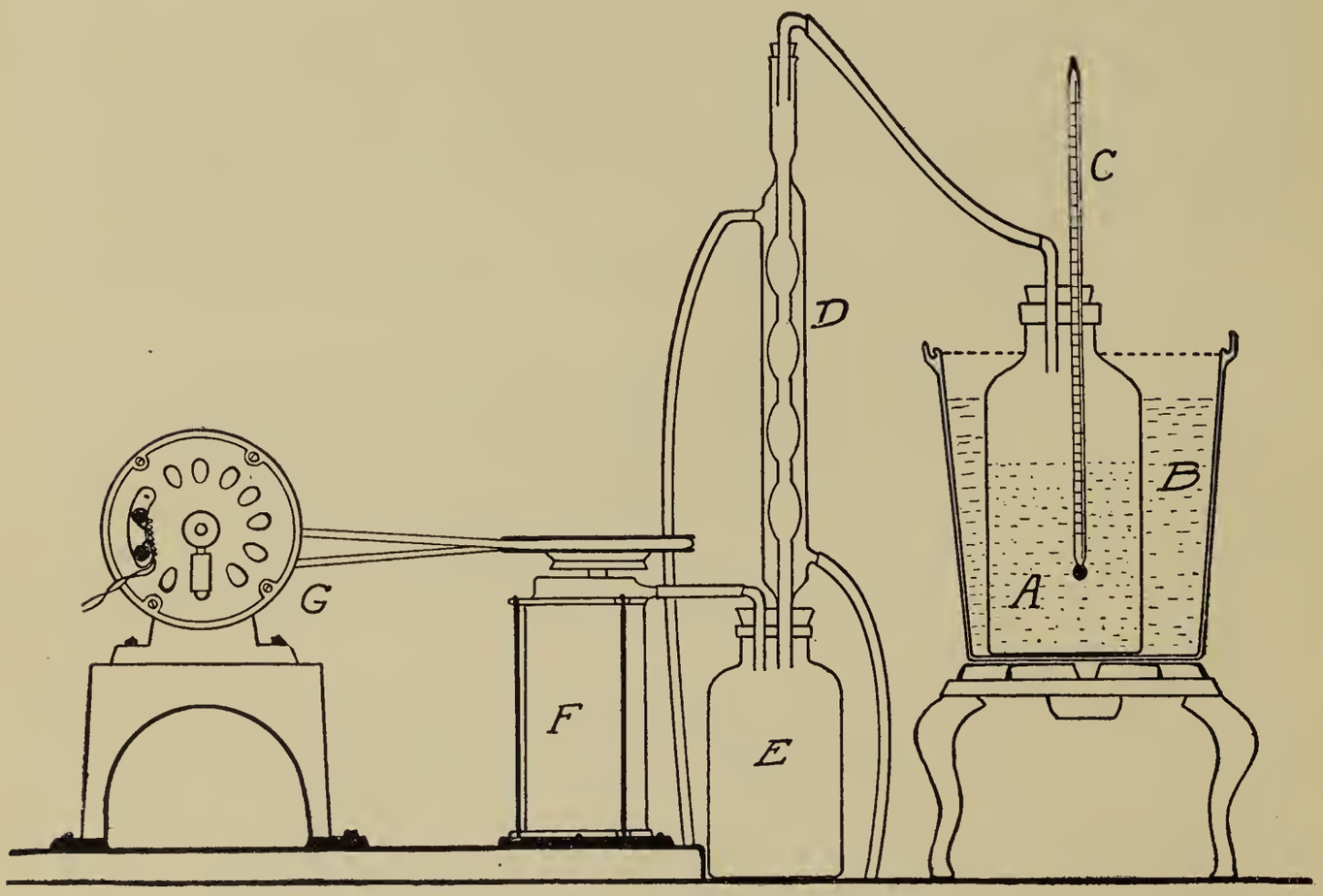

FIG. 9.—Sketch of laboratory apparatus for vacuum distillation. A, Boiling flask; B, Pot of water to heat boiling flask; C, Thermometer; D, Glass-condenser; E, Receiving bottle for distillate; F, Vacuum pump; G, Electric motor.

7. *Concentration by Freezing.*—Place a measured volume of the juice in a cold-storage room at 0° to 10°F. Allow to freeze to a mixture of ice crystals and syrup of "mushy" consistency. Place the partially frozen juice in a perforated centrifuge-basket and separate from the juice by centrifugal action. Repeat the freezing and centrifuging at least three times in order to obtain a concentrated juice of at least 50° Balling. Determine the yield and pasteurize as directed in Assignment XIV 2.

If a freezing room and centrifuge are not available the juice may be frozen in an aluminum or agate-ware pot immersed in an ice-and-salt mixture or in an ice-cream freezer and the syrup separated from the ice crystals by draining through a fine screen or cheese cloth.

8. *Berry Syrup by Addition of Sugar.*—Prepare juice from a weighed amount of berries as in Assignment XIII. Allow to settle and filter. Determine the acidity and the Balling degree. Add sufficient sugar to increase the concentration to 65° Balling. Determine the yield. Pasteurize as directed in Assignment XIV 2.

9. *Comparison of Samples.*—Store all prepared samples for four weeks or longer. Compare carefully with respect to flavor, color, odor, acidity and general quality. Also compare the experimentally prepared syrups with commercial syrups if obtainable. Determine the Balling degree and acidity of commercial samples.

Suggestions:

1. *Formula for Calculating Yield of Syrup:*

$$G = \frac{s \times b \times 100}{S \times B}$$

G = yield of syrup from 100 parts of juice by volume
s = specific gravity of juice
S = specific gravity of syrup
b = Balling degree of juice
B = Balling degree of syrup

2. *Formula for Reducing Acidity of Syrup by Neutralization of Acid in Juice Before Concentration:*

$$\left(\frac{J \times A}{S} - R\right) \times \frac{S}{N} = C$$

J = c.c. juice used
A = gms. acid per 100 c.c. juice
S = c.c. syrup obtained
R = gms. acid to be retained per 100 c.c. syrup
N = gms. acid neutralized by 100 gms. calcium carbonate
C = gms. calcium carbonate required

Theoretically 100 gms. calcium carbonate ($CaCO_3$) will neutralize 134 gms. malic acid ($C_4H_6O_5$) in apple juice or 150 gms. tartaric acid ($C_4H_6O_6$) in grape juice.

3. *Determination of Acidity of Syrups.*—On account of the viscosity of most syrups it is necessary to weigh a sample of the syrup (10 grams) for titration, rather than to measure the volume of the sample by means of a pipette.

4. *Determination of Balling Degree of Syrups.*—If syrup is very viscous it is necessary to mix 100 grams (not 100 c.c.) of the syrup with 100 c.c. of distilled water before making the Balling test. The reading thus obtained must be multiplied by 2.

ASSIGNMENT XV.—EXAMINATION OF COMMERCIAL JELLIES, JAMS, MARMALADES AND PRESERVES

Materials.—Samples of the above products.

Procedure:

1. Determine the net contents of the containers by weight.

2. Note the appearance, color, flavor, odor and clearness of each syrup or jelly. The samples should be examined carefully for evidence of mold growth and of fermentation.

3. Determine the Balling degree and total acid of the syrup from each preserve as directed in Assignment XIV. Place a 50-gram sample of jelly or marmalade in a weighed 400-c.c. beaker. Add exactly 100 c.c. of water. Heat and stir until dissolved. If necessary add water to replace that lost during heating. Cool and determine the Balling degree and acid. Multiply the results by three.

4. *Microscopical Examination.*—Mount small samples of the products on a microscope slide. Very concentrated products and jams should be diluted on the slide with a drop of distilled water. The presence of large numbers of micro-organisms, especially mold filaments or yeast cells, indicate the use of partially decomposed raw material.

5. *Artificial Color and Benzoate of Soda.*—The presence of artificial color or sodium benzoate may be determined qualitatively by the methods given in the Appendix, page 102.

Suggestions:

1. *Definitions—A.* Jelly.—Jelly is prepared by boiling fruit with or without water, expressing and straining the juice, adding sugar (sucrose) and concentrating to such consistency that gelatinization takes place on cooling. A perfect jelly is clear, sparkling, transparent and attractive in color. When removed from the glass it should retain its form and should quiver, not flow. It should not be syrupy, sticky or gummy and should retain the flavor and aroma of the original fruit. When cut it should be tender and yet so firm that a sharp edge and a smooth sparkling cut-surface remain.

B. Marmalade.—True marmalade is clear jelly in which is suspended slices of fruit or peel.

C. Jam.—Jam is prepared by boiling the whole fruit pulp with sugar (sucrose) without retaining the shape of the fruit. It is concentrated to a thick consistency without straining. Government pure-food regula-

tions require the use of not less than 45 pounds of fruit to each 55 pounds of sugar.

D. Butter.—Fruit butter is prepared by boiling the strained fruit pulp, with or without the addition of sugar, fruit juice or spices, to a semi-solid mass of homogeneous consistency. It differs from jam in being of a finer texture and a higher concentration.

E. Paste.—Fruit paste is prepared as described for fruit butter, but is concentrated to a semi-solid consistency by boiling and is then dried to a solid consistency resembling candy.

F. Preserves.—Preserves are made by cooking the prepared fruit in a sugar (sucrose) syrup until the concentration of sugar reaches 55 to 70 per cent. The fruit should retain its form, be crisp rather than soft, and should be permeated with the syrup. Government pure-food regulations require that not less than 45 pounds of fruit be used for each 55 pounds of sugar.

ASSIGNMENT XVI.—EXPERIMENTAL PREPARATION OF JELLY AND MARMALADE

Materials.—Sour apples 15 pounds, oranges 5 pounds, and lemons 5 pounds.

Procedure:

1. *Preparation.*—Prepare jelly stock from a weighed amount of sour apples (about 15 pounds), as directed in Assignment XVII. Test qualitatively for pectin content as directed in Assignment XVII. If the juice is not rich in pectin, concentrate by boiling until a heavy pectin precipitate is obtained by the alcohol test. Record the yield, acidity and Balling degree.

2. *Effect of Pectin Concentration.*—*A.* Dissolve 185 grams of sugar in 100 c.c. of the prepared juice. Heat to boiling for one minute. Skim and pour into a glass.

B. To 50 c.c. of the juice add 50 c.c. of water. Add 185 grams of sugar and treat as in *A.*

C. To 25 c.c. of the juice add 75 c.c. of water, 185 grams of sugar and proceed as in *A.*

Compare consistencies of the samples after 48 hours.

3. *Effect of Acidity.*—*A.* If the acidity of the juice is less than 1 per cent., increase the acidity of 100 c.c. to 1 per cent. by the addition of citric acid. Add 185 grams of sugar, dissolve, and heat to boiling for one minute. Skim and pour into a glass.

B. Repeat *A,* increasing the acidity to 2 per cent.

C. Repeat *A,* increasing the acidity to 5 per cent.

D. Reduce the acidity of 100 c.c. of juice to 0.2 per cent. by the addition of the calculated amount of sodium carbonate (Na_2CO_3). One gram of Na_2CO_3 will neutralize 1.21 grams citric and 1.26 grams malic acid. Add 185 grams of sugar, boil one minute; skim and pour into a glass.

Compare the consistencies and flavors of samples after 48 hours.

4. *Effect of Sugar Concentration.*—To 100 c.c. portions of the juice add 50, 150, 200 and 300 grams of sugar, respectively. Dissolve the sugar, boil each sample one minute, skim and pour into glasses.

Compare the consistencies and flavors after 48 hours. Note the presence or absence of sugar crystals.

5. *Effect of Temperature.*—Dissolve in each of three 100-c.c. portions of juice 185 grams of sugar. Heat one lot to boiling one minute, the second lot to 165°F. one minute, and the third lot in an autoclave at 10 pounds steam pressure (240°F.) five minutes.

Compare for color, flavor and consistency after 48 hours.

6. *Comparison of Jelling-point Tests.*—To each of four 100-c.c. lots of the juice add 100 grams of sugar. Boil in an open pot with a thermometer inserted in the boiling liquid. Remove lot 1 when the heating point reaches 216°F.; lot 2 at 218°F.; lot 3 at 221°F., and lot 4 at 225°F. Also allow some of the hot liquid to drip from a spoon and note whether the drops congeal or not, and determine the Balling degree of each lot as soon as removed from the fire (making the necessary temperature corrections).

Compare the flavors, colors and textures after 48 hours.

7. *Jelly from Dried Apple Waste.*—To 100 grams of dried peels and cores of apples (canning refuse) or of dried pomace from apple-juice manufacture add 500 c.c. of water. Bring to the boiling point and set aside overnight. Boil about 20 minutes, press and filter.

Test for pectin and if necessary concentrate until a fairly heavy test is given.

Add an equal quantity of berry juice, such as strawberry juice or commercial grape juice, and sugar in the proportion of 75 grams per 100 c.c. of mixed juice and concentrate to a boiling point of 221°F. Pour into glasses and store for subsequent examination.

8. *Citrus Fruit Marmalade—A.* Preparation.—Prepare jelly stock from a weighed amount of citrus fruit, about 5 pounds each of oranges and lemons, as directed in Assignment XVII. Test qualitatively for pectin content and, if a heavy test is not secured, concentrate by boiling. Record the yield, acidity and Balling degree.

B. Effect of Preliminary Boiling of Peel.—To 200 c.c. of the juice add 30 grams of shredded peel and 150 grams of sugar. Boil until a thermometer in the liquid registers 221°F. and pour into a glass.

To 30 grams of the shredded peel add about 300 c.c. of water. Boil until the shreds are tender. Drain off and discard the water. To the drained peel add 200 c.c. of juice and 150 grams of sugar. Heat to 221°F. Pour into a glass.

Compare the texture of the peel in the two lots after 48 hours. Measure the yield of finished product.

C. Effect of Cooling before Pouring.—Prepare a sample of marmalade as directed in *B,* using the boiled peel, but allow the product to cool in the pot with occasional stirring until it shows slight signs of jelling. Pour it into a glass and after cooling note whether the shreds are more evenly distributed in the product than in *B.*

D. Effect of Proportion of Peel.—To 100-c.c. lots of the juice add 5, 10, 20 and 30 grams, respectively, of thinly sliced boiled peel and 100 grams of sugar. Concentrate each lot until a boiling point of 221°F. is reached. Pour into glasses. Compare as to texture, appearance and general quality after 48 hours.

ASSIGNMENT XVII.—PRACTICE IN THE PREPARATION OF JELLY AND MARMALADE

Materials.—Any fruit in season suitable for jelly making.

Procedure:

1. *Condition of Fruit.*—Fruit for jelly should be sound and clean and not thoroughly ripe, as under-ripe fruit is richest both in pectin and in acid.

2. *Extraction of Pectin.*—The pectin must be released from the fruit tissues by boiling. Very juicy fruits such as berries are merely crushed and boiled about 5 minutes without the addition of water. Hard fruits such as quinces or apples are cut into small pieces, barely covered with water and boiled 10 or 15 minutes till tender. Citrus fruits are sliced without peeling into thin pieces, covered with water and boiled about one hour.

3. *Pressing and Clearing.*—With large quantities, the boiled fruit is pressed as described under Fruit Juices. The juice is allowed to settle overnight and the settled juice filtered through a felt jelly-bag. Small quantities of boiled fruit are generally placed directly in a muslin jelly-bag and the clear juice allowed to drain through. The last of the juice may be squeezed out, but it will be cloudy. The drained or pressed pulp of fruits rich in pectin may be boiled a second time with water and drained or pressed.

4. *Orange Peel for Marmalade.*—If equal quantities of oranges and lemons are used for the marmalade stock, only one orange in four need be peeled. Remove the orange peeling by quarters and cut into very thin slices, not more than 1/32 of an inch thick. Boil the sliced peel in water until tender. Drain and discard the water.

5. *Testing for Pectin.*—Mix in a glass equal quantities of juice and 95 per cent. grain alcohol. One spoonful or about 10 c.c. of each is sufficient. The character and amount of precipitate indicate the relative concentration of pectin as follows:

Juice rich in pectin = bulky, gelatinous, almost solid mass of pectin.

Juice moderately rich in pectin = a few large pieces of gelatinous precipitate.

Juice poor in pectin = small amount of flaky sediment.

6. *Testing for Acid.*—The acidity of the jelly stock may be determined as described on page 98. An acid content of 0.5 to 1.0 per cent.

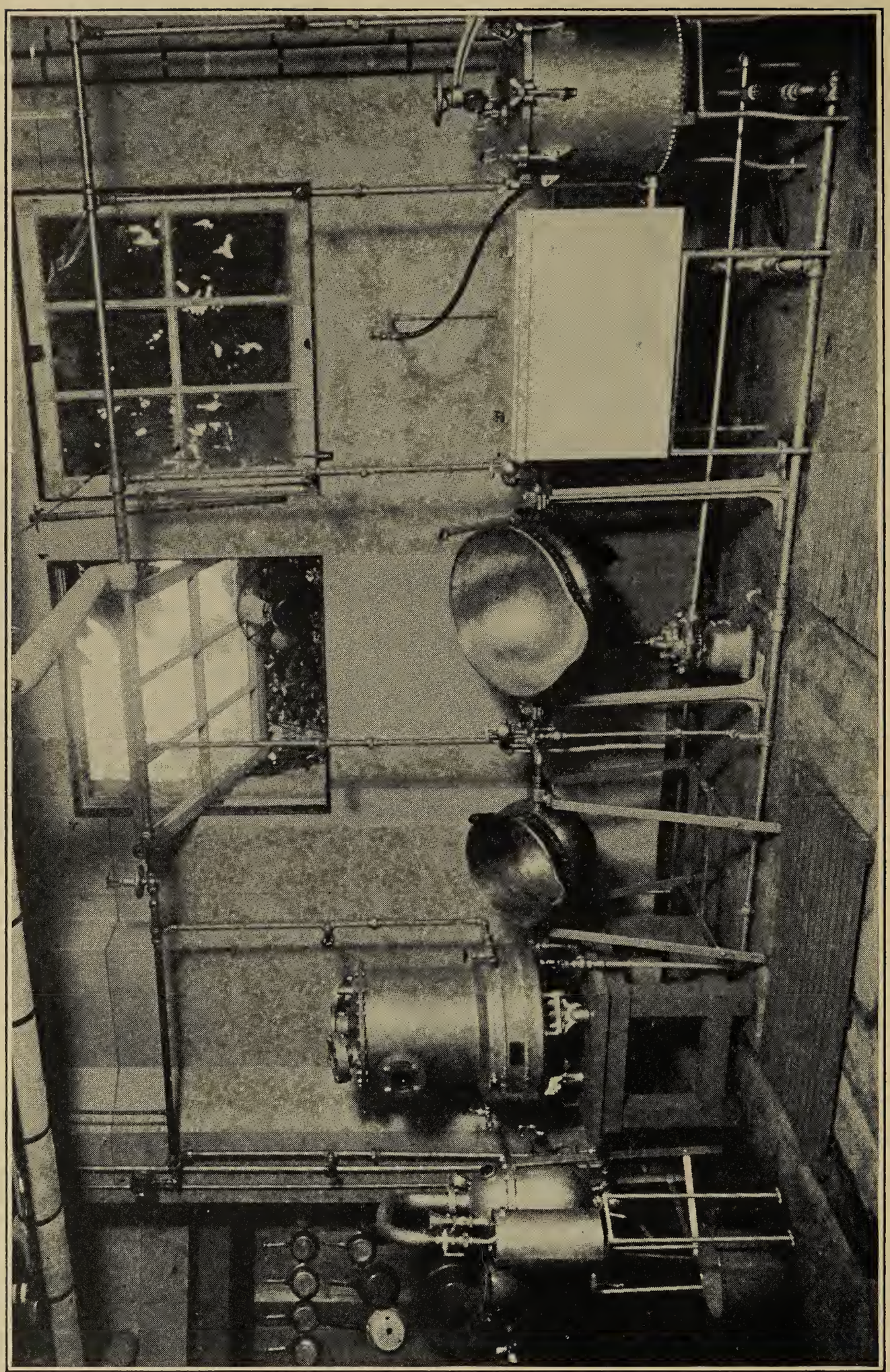

FIG. 10.—View in Fruit Products Laboratory, University of California, showing steam jacketed jelly kettles, vacuum pans and sterilizers.

is satisfactory. Juices with a distinctly tart taste need not be tested for acid.

7. *Proportion of Sugar and Juice.*—The amount of sugar which may be added to the juice is directly proportional to the concentration of pectin in the juice, as follows:

To one cup of juice rich in pectin add 1 to 1½ cups of sugar.

To one cup of juice moderately rich in pectin add ¾ to 1 cup of sugar.

To one cup of juice fairly rich in pectin add ½ to ¾ cup of sugar.

Juices poor in pectin should be concentrated until a satisfactory pectin test is obtained before addition of sugar.

8. *Determination of Jelling Point.*—The proper proportion of sugar and juice is boiled rapidly until the mixture reaches a concentration of 65° to 68° Balling (cold test). The jelling point may be determined in the following ways, the thermometer test being the simplest and most reliable:

A. Sheeting Test.—Dip a spoon or paddle in the boiling jelly. Hold the spoon in the air and allow the jelly to drip from it. If the drops are syrupy the jelly is not sufficiently concentrated, but if the jelly congeals or drops in flakes the jelling point has been reached.

B. Boiling-point Test.—Place a thermometer in the jelly during concentration. When the jelly boils at 221°F., equivalent to 65° Balling, the jelling point is reached.

C. Balling Test.—Pour a sample of the boiling jelly in a hydrometer cylinder and determine Balling degree. At the jelling point the Balling degree of the hot jelly should be 57° to 58°, equal to 65° when cold.

9. *Sealing, Pasteurizing and Storage.*—The hot finished jelly, skimmed to insure clearness, is poured into glasses and allowed to cool and solidify. The surface of the jelly is then covered with a layer of hot melted paraffine, which sterilizes the surface of the jelly and solidifies to form a seal about ⅛ inch thick.

Jelly may also be sealed in small fruit-jars with caps and rubber gaskets or in lacquered cans. This is necessary where the jelly is to be pasteurized at 180°F. for 30 minutes in the case of soft jellies that are below 65° Balling, and especially if to be kept in hot climates.

Suggestions:

1. *Suitability of Fruits for Jelly:*

Rich in Pectin and Acid	Medium in Acid and Pectin	Rich in Pectin and Low in Acid	Poor in Acid and Pectin
Jell readily	Jell if carefully handled	Add acid fruit	Blend with fruit from Column 1
Sour apples	Ripe apples	Guavas	Apricots
Crab apples	Blackberries	Feijoas	Peaches
Currants	Oranges	Figs	Pears
Loganberries	Grape Fruit	Pie melons	Raspberries
Cranberries	Sweet plums		Strawberries
Lemons	Quinces		
Sour plums	Sour cherries		
Eastern grapes	California grapes		

2. *Common Difficulties in Jelly-making, with Cause or Prevention.*—

A. Soft or Syrupy Jelly.—Too much sugar for amount of pectin or insufficient boiling; add more juice or pectin and heat to 221°F.

B. Tough Jelly.—Too little sugar for amount of pectin; add more sugar.

C. Gummy Jelly.—Too prolonged boiling or over-cooking; boil rapidly and stop at 221°F.

D. Cloudy Jelly.—Juice not strained; jelly not skimmed or partly congealed before filling into glasses; use clear juice, skim jelly and pour hot into glasses.

E. Crystals.—Sugar crystals due to lack of thorough stirring and dissolving or too much sugar added or jelly too concentrated. In grape jelly the harmless cream of tartar crystals may occur.

F. Moldy Jelly.—Paraffine not hot when poured or caps not sterilized or seal not tight. Use thicker layer of hot melted paraffine or sterilized covers.

G. Fermented Jelly.—Not concentrated to 65° Balling. Add more sugar, heat to 221°F., or pasteurize in sealed jars.

ASSIGNMENT XVIII.—EXPERIMENTAL PREPARATION OF PECTIN AND JELLY STOCK

Materials.—Apples 10 pounds, or oranges and lemons 5 pounds each. Cull fruits may be used. Commercial powdered pectin and concentrated pectin solution.

Procedure:

1. *Preparation of Juice.*—Prepare jelly stock from apples or equal weights of lemons and oranges as directed in Assignment XVII. Test qualitatively for pectin content. If the juice is not rich in pectin, concentrate by boiling. Determine the yield, acidity and Balling degree.

2. *Canned Jelly Stock.*—To 100 c.c. of the juice add 100 grams of sugar and concentrate to a boiling point of 221°F. Pour into a glass, seal and store for future reference.

Fill to overflowing with the boiling juice one lacquered can and one plain tin can. Seal at once and invert to cool. Store at least one month. Open cans and note action of juice on containers. Prepare jelly from each sample as directed above and compare the quality with that of jelly made from the fresh fruit.

3. *Preparation and Use of Concentrated Pectin Solution.*—Determine the acidity and Balling degree of a sample of commercial concentrated pectin solution. Concentrate *in vacuo* 500 c.c. of the jelly stock to the same Balling degree as the commercial pectin solution. Compare the pectin content of each of the two products qualitatively after diluting one part of the sample with four parts of water.

Pasteurize the concentrated pectin solution in a bottle at 175°F. for 30 minutes. Store 1 month. Dilute part of the sample to the concentration of the original juice. To 100 c.c. of the diluted solution add 100 grams of sugar and heat to 221°F. Compare with the jellies made from canned jelly stock and fresh juice in Assignment XVIII 2.

To 100 c.c. of strawberry juice, or other juice poor in pectin, add enough of the concentrated pectin solution to give a strong pectin test and record the amount used. Prepare jelly as directed above. For comparison add to 100 c.c. of the juice poor in pectin enough concentrated commercial pectin solution to give a strong pectin test and prepare jelly from the mixture. Compare amounts of the two pectin solutions required to give similar qualitative pectin tests and compare the jellies obtained as to quality.

4. *Preparation of Powdered Pectin.*—Concentrate 1,000 c.c. of the jelly stock *in vacuo* to about 45° to 50° Balling. Cool, and add the concentrated juice slowly with stirring to twice its volume of 95 per cent. ethyl (grain) alcohol. Separate the alcohol from the pectin by draining through a muslin cloth and pressing. Dry at room temperature on a screen. Dissolve the dried pectin in a small amount (about 150 c.c.) of water and strain through a cloth. Add the pectin solution to twice its volume of ethyl alcohol and separate the precipitate by straining through muslin. Dry at a temperature of 120° to 130°F. and weigh. Grind in a mortar to a powder. Store in a corked bottle.

Dissolve 0.5, 1 and 2 grams, respectively, in 100-c.c. lots of juice poor in pectin. Add 100 grams of sugar to each. Concentrate by boiling to 221°F. Pour into glasses and compare the samples 48 hours later as to consistency.

Suggestions.—The alcoholic liquid from the pectin precipitation may be distilled to recover the alcohol, the alcohol content of the distillate determined and the loss of alcohol ascertained.

ASSIGNMENT XIX.—PRACTICE IN THE PREPARATION OF JAM, BUTTER AND PASTE

Materials.—Apples 10 pounds, peaches or apricots 5 pounds, berries 5 pounds and pears 5 pounds. Fruits for the products above mentioned should be thoroughly ripe.

Procedure:

1. *Jams—A.* Preparation.—Weigh and wash the fruit thoroughly. Do not use apples. Peel and slice peaches and pears. Pit and slice apricots. Wash and stem berries. Firm fruits such as pears should be boiled until soft with a small amount of water before adding sugar.

B. Addition of Sugar.—To sour fruits add an equal weight and to sweet fruits three-fourths their weight of sugar.

C. Concentration.—Heat with constant stirring to a boiling point of 218° to 221°F., or until the desired consistency is reached. Seal while boiling hot in jars or glasses. Record the yield.

2. *Butters—A.* Preparation of Pulp.—Weigh, peel and slice apples, pears or peaches. Boil with a small amount of water until soft. Pass through a fine screen.

B. Addition of Sugar or Fruit Juice.—Butters are made either with sugar or fruit juice added to pulp. If the former is used, add three-fourths pound of sugar per pound of pulp; if the latter, add 3 pints of apple juice or grape juice per pound of pulp.

C. Addition of Spices.—Cinnamon and cloves are usually added in the proportion of one level teaspoonful of each of the ground spices per 3 pounds of pulp or one gram of each per 1,000 grams of pulp. These are added near the completion of the boiling process.

D. Lemon juice is added to pear pulp in the proportion of three-fourths of a pint per 10 pounds of pulp or 50 c.c. per 1,000 grams of pulp.

E. Concentration.—Concentrate the pulp and sugar or juice to a very thick consistency (222° to 225°F.). Determine the yield and seal while hot in fruit jars or cans.

3. *Paste.*—Use pears, peaches, apricots or berries. Prepare the fresh fruit as described for butters. Add to the screened pulp three-fourths its weight of sugar. Concentrate to a boiling point of 222°F. Spread in a layer about ½ inch thick in a buttered or greased pan. Dry to a solid consistency at 120° to 160°F. in an air-blast dehydrater or in a

glass-covered dish in the sun. Cool. Cut into square blocks. Dip in powdered sugar and determine the yield.

Suggestions.—Commercial pectin or apple juice rich in pectin is often added to fruit jam to thicken its consistency or to cheapen the product.

ASSIGNMENT XX.—EXPERIMENTAL PREPARATION OF FRUIT PRESERVES

Materials.—Strawberries 5 pounds, and cherries, oranges or slightly unripe figs 3 pounds. If fresh strawberries are not in season it is usually possible to obtain cold-storage strawberries.

Procedure:

1. *Effect of Preliminary Cooking.*—Use fresh whole figs or the white flesh of watermelon cut in small cubes, or orange peel cut in quarters.

A. To 1 pound (454 grams) of the fruit, add 1 pound (454 grams) of sugar and ½ pint (about 240 c.c.) of water, boil to 221°F. and allow to cool.

B. To 1 pound (454 grams) of the fresh fruit, add 2 pints (about 950 c.c.) of water and boil until tender. This will be 45 to 50 minutes for orange peel and 20 to 25 minutes for figs or melon. Discard the water. To the cooked fruit add 1 pound (454 grams) of sugar and ½ pint (about 240 c.c.) of water. Heat slowly to 221°F. Allow to cool and compare the texture with that of sample *A*.

2. *Effect of Method of Concentration.*—*A.* Place 1 pound of hulled washed strawberries in an open kettle. Add 1 pound of sugar. Heat to 221°F. and allow to cool.

B. Place equal weights of berries and sugar in a large flask connected to a condenser and vacuum pump. Place the flask in water at 185°F. and concentrate under at least 26 inches vacuum until the syrup tests 65° Balling (corrected for temperature). Allow to cool and compare with *A* and *C*.

C. To 1 pound of berries add 1 pound of sugar. Heat slowly to boiling. Boil 3 minutes. Allow to stand with occasional stirring for about 12 hours to permit the berries to absorb the syrup. Heat to 185°F., pack hot into a jar; seal; pasteurize 20 minutes at 185°F. and invert to cool. Compare with *A* and *B*.

D. To 1 pound of berries add 1 pound of sugar. Boil 3 minutes and place in a shallow dish in the sun or in a dehydrater at 120°F. until syrup reaches 65° Balling. Compare with *A*, *B* and *C*.

Suggestions.—If fresh fruits are not in season dried figs, peaches or pears may be soaked in water and used for this assignment.

ASSIGNMENT XXI.—PRACTICE IN THE PREPARATION OF FRUIT PRESERVES

Materials.—Five pounds each of such fruits as peaches, pears, strawberries, pineapple, watermelon rind, kumquats, cherries, apricots and firm ripe figs.

Procedure:

1. *Preparation.*—Weigh the fruit before and after preparation as follows:

A. Freestone peaches—peel, halve, pit.
B. Cling-stone peaches—peel, but need not pit.
C. Small pears—peel and use whole.
D. Large pears—peel, halve, core.
E. Quinces—peel, quarter and core.
F. Cherries—stem and pit.
G. Apricots—halve and pit.
H. Small plums—puncture skins thoroughly.
I. Kumquats—slit and seed.
J. Pineapple—peel, core and slice.
K. Watermelon—remove red flesh and green skin.

2. *Preliminary Boiling.*—Boil watermelon rind and fruits, such as figs, peaches, pears, kumquats and cherries, in water until tender. Do not boil soft fruits, such as berries and very ripe apricots or free-stone peaches.

3. *Addition of Sugar.*—To each pound of firm varieties of fruit add 1 pound of sugar and 1 quart of water. To berries and very ripe soft fruit add sugar only. Heat firm fruits in an open kettle to a temperature of 221°F.; boil berries with gentle stirring 3 to 4 minutes only. Allow to cool in an open vessel, stirring frequently during cooling. Set aside for 24 hours to allow the fruit to absorb the syrup.

4. *Packing and Pasteurizing.*—Pack the fruit carefully into glass jars. Heat the syrup from the fruit to boiling and fill the jars. Seal the jars and pasteurize for 30 minutes in water at 185°F.

5. *Spiced Preserves.*—Prepare firm fruits as directed in Assignment XXI 1 and 2. Berries are not suitable for spiced preserves. Prepare a syrup consisting of:

Sugar	1,400 grams
Vinegar	475 c.c.
Water	475 c.c.
Ginger root	7 grams
Whole cloves	10 grams
Stick cinnamon	15 grams

Heat the fruit to boiling in this syrup and allow to stand overnight. Add sugar sufficient to increase the Balling degree of the syrup to 60°. Heat the fruit and syrup to boiling. Pack hot into jars and seal. No further treatment is necessary.

6. *Maraschino Cherries.*—Store large Royal Anne cherries for at least two weeks in sealed glass-top fruit-jars in a 0.3 per cent. solution of sulphurous acid or in a 0.5 per cent. solution of sodium metabisulphite.

Stem and pit the cherries. Allow to stand in water overnight. Boil in repeated changes of water until the fruit is tender and free of sulphurous acid taste.

Prepare a syrup of 30° Balling with confectioners' gluecose or white "Karo" syrup and water. Color the syrup to the desired depth and tint by the addition of small amounts of the permissible coal-tar dyes, Amaranth and Ponceau-3-R. Heat the fruit to boiling in this syrup and set aside for 24 hours. Increase the Balling degree progressively at 24-hour intervals to 35°, 40°, 45°, 50° and 55° Balling by addition of cane-sugar, boiling the fruit and syrup for about three minutes after each increase. Add a very small amount of bitter-almond or "wild cherry" extract to the syrup of 55° Balling, heat to boiling and pack into glass-jars or lacquered-cans. Seal and sterilize the cans in boiling water for 10 minutes and the jars in water at 185°F. for 20 minutes. A more attractive product is obtained if the cherries are packed in freshly prepared cane-sugar syrup of 55° Balling flavored with bitter-almond oil.

ASSIGNMENT XXII.—PRACTICE IN THE PREPARATION OF CANDIED FRUITS

Materials.—Apricots, cherries, figs, jujubes, oranges, kumquats, small Seckel pears or canning peaches. Most fruits for candying should be hard ripe.

Procedure:

1. *Preliminary Treatment.*—Take a weighed quantity of the fruit. Jujubes are first dipped in boiling 1 per cent. sodium hydroxide (NaOH) solution for about ½ minute and rinsed in water to remove the waxy coating on the skin and to render the skin permeable to the syrup. Some whole fruits such as apricots should be punctured thoroughly with a fork. Cherries are pitted and stemmed. Peaches are peeled, pitted and halved. The pits are removed from large apricots without cutting in half. Use only the peel of oranges. The skins of kumquats are cut longitudinally and the seeds are removed.

Cook the fruit in water until tender, but not "mushy."

2. *Impregnation with Syrup.*—Prepare a glucose syrup of 30° Balling from glucose syrup and water. Place the fruit in this and heat to boiling. Set aside for 24 to 48 hours.

Pour off the syrup. Add cane-sugar to increase to 40° Balling. Place the fruit in the syrup. Heat to boiling. Set aside for 48 hours.

Increase the syrup progressively at 48-hour intervals to 50°, 60° and 70° Balling by the addition of cane-sugar. Heat the syrup and fruit to boiling after each increase.

The syrup used for cherries must be artificially colored to give the tint commonly seen in candied cherries. Equal proportions of the permissible aniline colors Ponceau-3-R and Amaranth are used. These are added when the first syrup is prepared. Bitter-almond flavor is added to the final syrup for cherries.

3. *Drying and "Glacéing."*—Remove the fruit from the heavy syrup. Drain well on screen trays. Dry the surface of the fruit at not over 130°F. Weigh. Part of this fruit may be packed in boxes without further treatment. Reserve the remainder for glacéing.

Prepare a concentrated sugar-solution containing 60 grams of sugar and 25 grams of glucose-syrup per 15 c.c. of water. Boil and allow to cool to about 200°F. Dip the remainder of the fruit in this very heavy syrup. Drain and dry in the open air at not above 110°F.

Weigh the finished product. Compare the appearance of the glacé and plain samples.

Suggestions:

1. If fresh fruits are unavailable, canned fruits may be substituted.
2. Apples, berries and very ripe fruits of any kind are unsuitable for candying because they disintegrate during processing.
3. Cherries are usually prepared for candying as described in Assignment XXI-6.

ASSIGNMENT XXIII.—EXAMINATION OF COMMERCIAL DRIED FRUITS AND VEGETABLES

Materials.—Samples of various size-grades of sun-dried fruits, such as peaches, pears, apricots, prunes and raisins. Samples of dehydrated fruits, such as prunes, apples, berries, peaches, pears, etc. Samples of dehydrated vegetables, such as spinach, corn, string beans, soup vegetables and of pumpkin flour.

Procedure:

1. *General Examination.*—*A.* Appearance.—Note the shade and uniformity of color, comparing with the natural color of the fresh product. In dried whole fruits, note the appearance of the interior of each. Note differences in color between sun-dried and dehydrated fruits. Examine carefully for dust, dirt, straw and evidence of carelessness in peeling or washing.

B. Flavor.—Note the flavor of each kind of fruit. Taste for evidence of sulphurous acid or caramelization of sugar.

C. Evidence of Spoiling.—Examine for evidences of insect infestation. The common insects which may be found in dried fruits or vegetables are, in order of their importance:

(*a*) Indian-Meal Moth (Plodia interpunctella).
(*b*) Dried-Fruit Beetle (Carpophilus hemipterus).
(*c*) Grain Beetle (Silvanus surinamensis).
(*d*) Dried-Fruit Mite (Carpoglyphus passularum).

Examine for evidence of micro-biological decomposition, namely, mold, alcoholic fermentation or bacterial growth. A small portion of the sample may be ground with a little water in a mortar and a drop of the mixture placed on a glass slide and examined under the high power of the microscope. Do not confuse efflorescence of sugar on the surface of fruits with white mold.

2. *Grades.*—Determine the size grades of dried fruits by reference to Table X.

3. *Chemical Examination.*—*A.* Determination of Moisture.—Grind a representative sample of not less than 1 pound of fruit, free from pits, or ½ pound of vegetable, through a fine food-chopper. Determine the moisture by the official method as given on page 102. Moisture in dried apples may be determined by drying 10 grams of the minced sample in a

water-oven for *exactly* 4 hours at not less than 96°C. This method does not apply to other fruits. The legal limit for moisture in dried apples is 24 per cent. Legal limits for moisture in other dried fruits and vegetables have not been adopted.

B. Sugar in dried fruits may be determined as outlined on page —.

C. Sulphurous acid in sulphured fruits may be determined as outlined on page 100.

4. *Refreshing Test.*—*A.* Place an accurately weighed amount of dried fruit or vegetable (½ pound or less) in a pot and cover with boiling water and allow to stand 12 to 24 hours.

B. Drain on a piece of screen of ⅛-inch mesh and record the increased weight of the product.

C. Return the drained product to the liquid and boil gently until tender, adding sugar, salt or spices to taste.

D. Note the color, odor and flavor of the cooked product.

Suggestions:

1. A brief description of the standard grades of California dried fruits is given in Table X.

TABLE X.—GRADES OF CALIFORNIA DRIED FRUITS

APPLES, Evaporated (Artifically dried):

Extra Fancy.—Fairly uniform size rings; uniform white color; clean; free from skins, cores, stems, bruised or rotten spots, worm holes or screening.

Fancy.—Fairly uniform size rings; uniform white or very light yellow color; clean; almost free from skins, cores, stems, bruised or rotten spots, worm holes or screenings.

Extra Choice.—Rings of fairly uniform white or light yellow color; not more than 25 per cent of pieces showing skins, cores, stems, bruised or rotten spots or worm holes; fairly free from screenings.

Choice.—Rings of white, yellow or light brown color; not more than 50 per cent of pieces showing skins, cores, stems, bruised or rotten spots, worm holes; may contain noticeable amount of screenings.

Standard.—Brown color; large percentage of pieces showing skins, cores, stems, bruised or rotten spots and of screenings.

APRICOTS, California Sun Dried:

Size Grades.—Extra Fancy, over 48/32 inches diameter.

Fancy	48/32 inches diameter.
Extra Choice,	40/32 inches diameter.
Choice,	32/32 inches diameter.
Standard, below	32/32 inches diameter.

Quality Grades.—Dried apricots are sold according to variety and locality, Blenheims and Moorparks predominating in the Santa Clara Valley and the Royal in the Sacramento and San Joaquin Valleys and southern California. Two general quality grades are recognized:

First.—Bright colored, well bleached, meaty, clean, neatly cut halves.

Second.—Darker, not so well bleached, thinner, or ragged edges.

FIGS, California Sun Dried:

Black Figs (Mission Variety):

Fancy, over 34/32 inches diameter.
Choice, 34/32 inches diameter.
Standard, 28/32 inches diameter.

White Figs (Calimyrna and Adriatic Varieties):

Fancy, over 42/32 inches diameter.
Choice, 42/32 inches diameter.
Standard, 34/32 inches diameter.

PEACHES, California Sun Dried:

Size Grades.—Extra Fancy, over 58/32 inches diameter.
Fancy, 58/32 inches diameter.
Extra Choice, 50/32 inches diameter.
Choice, 42/32 inches diameter.
Standard, 34/32 inches diameter.

Classes.—Dried peaches are divided into two broad classes, namely "Muirs" and "Yellows," the latter including several yellow-fleshed, freestone varieties, principally the Lovell and Elberta. Dried peaches are sold both unpeeled and "Practically Peeled," the latter term designating peaches which have had the fuzzy skin removed after being dried.

PEARS, California Sun Dried:

Because of their distinctive shape, dried pears are graded by hand according to their size, color and general appearance into Extra Fancy, Fancy, Extra Choice, Choice and Standard grades for which no simple definitions can be given.

PRUNES, California Sun Dried:

Size Grades.—No. per Pound.	Diameter of Grader Holes.
20 to 30	over 40/32 inches
30 to 40	40/32 inches.
40 to 50	38/32 inches.
50 to 60	36/32 inches.
60 to 70	33/32 inches.
70 to 80	32/32 inches.
80 to 90	30/32 inches.
90 to 100	28/32 inches.
100 to 110	26/32 inches.
110 to 120	24/32 inches.
120 and up	below 24/32 inches.

Quality Grades.—Dried prunes are sold according to locality where grown, such as Santa Clara, Sacramento, San Joaquin, Sonoma or Napa Valleys. Two general quality grades are known:

First.—Uniform amber colored meat of fine flavor; skin in good condition and of deep black color.

Second.—Brown colored flesh, not so meaty and fine flavored; reddish brown colored skin.

RAISINS, California Sun Dried:

A. Muscat Raisins (with seeds).

1. Layers (unbroken bunches of perfect raisins).
(*a*) Vineyard Run.
(*b*) Layers (Three crown size), see below.
(*c*) Clusters (Four crown size), see below.
(*d*) Imperials (Six crown size), see below.
2. *Loose Muscats* (stemmed raisins):
(*a*) One crown, 13/32 inches diameter.
(*b*) Two crown, 17/32 inches diameter.
(*c*) Three crown, 21/32 inches diameter.
(*d*) Four crown, over 21/32 inches diameter.
3. *Seeded Muscats* (above sizes of stemmed and seeded raisins):
B. Sultanina Raisins (seedless):
1. Natural (stemmed raisins):
(*a*) *First*, plump raisins of even color and size.
(*b*) *Second*, uneven color or size and not well filled out.
2. *Bleached* (bleached to a light yellow color):
(*a*) *Extra Fancy*, fine large raisins of even yellow color.
(*b*) *Fancy*, not perfectly bleached.
(*c*) *Choice*, inferior to above grades.
3. *Oil and Soda Dipped.*

C. Miscellaneous Varieties.—*Sultanas*, practically seedless; Valencias, bleached Muscats; *Malagas* and *Feherzagos* are stemmed and packed in the same way as loose Muscat raisins.

D. Currants.—Very small, stemmed, seedless raisins obtained from the Zante or Black Corinth grapes.

ASSIGNMENT XXIV.—EXPERIMENTAL DRYING OF FRUITS AND VEGETABLES

Materials.—Fresh fruits and vegetables in season as directed under "Procedure."

Procedure:

1. *Comparison of Sun-drying and Dehydration.*—Prepare two trays each of apples and white potatoes as directed in Assignment XXV. Record the exact weight of material on each tray before and after preparation. Place one tray of each product in a sunny location out of doors and record the loss in weight daily until sufficiently dry. Do not expose during moist weather. Place the other tray of each product in a small air-blast dehydrater at 150°F., and record the loss in weight hourly until sufficiently dry. Plot the comparative rates of drying. Compare the cleanliness, color, flavor and odor of the refreshed and cooked products. If procurable, interesting comparisons can be obtained by using a green vegetable, such as spinach or string beans, or fruits such as bananas, pears and berries.

2. *Effect of Lye-dipping.*—Weigh accurately two equal tray-loads of prunes, grapes or cherries. Dip one lot in boiling 0.5 per cent. sodium hydroxide solution until the bloom is removed and the skins slightly checked. Muscat and wine grapes require a 2.5 per cent. solution. Rinse in cold water and spread on a tray. Dry both trays in an air-blast dehydrater at 150° to 160°F. Record the loss in weight hourly and plot the comparative rates of drying. Compare the dried samples as to color and flavor.

3. *Effect of Blanching.*—Prepare two weighed trays each of one or more products such as spinach, peas, cubed potatoes, sliced pumpkin, and cubed carrots. Blanch one tray of each in a steam box; potatoes 3 minutes, other vegetables 5 minutes. Dry all trays in an air-blast dehydrater at 150°F., plotting the hourly losses in weight. Compare the color and flavor of each before and after cooking.

4. *Effect of Sulphuring.*—Prepare two trays each of one or more products such as peeled and sliced apples, halved and pitted apricots or peaches, or peeled halved pears. Expose one tray of freshly prepared fruit to the fumes of burning sulphur for 1 hour. (*Caution:* Sulphured fruits must not be dried on metal trays. Use wooden slat-bottom trays.)

Dry all trays in an air-blast dehydrater at 150°F. and compare the color and flavor of the dried products.

5. *Effect of Size of Pieces on Drying.*—Prepare four trays of peeled and cored apples as follows:

A. Halves, *B*. quarters, *C*. slices ¼ inch thick, *D*. ½-inch cubes.

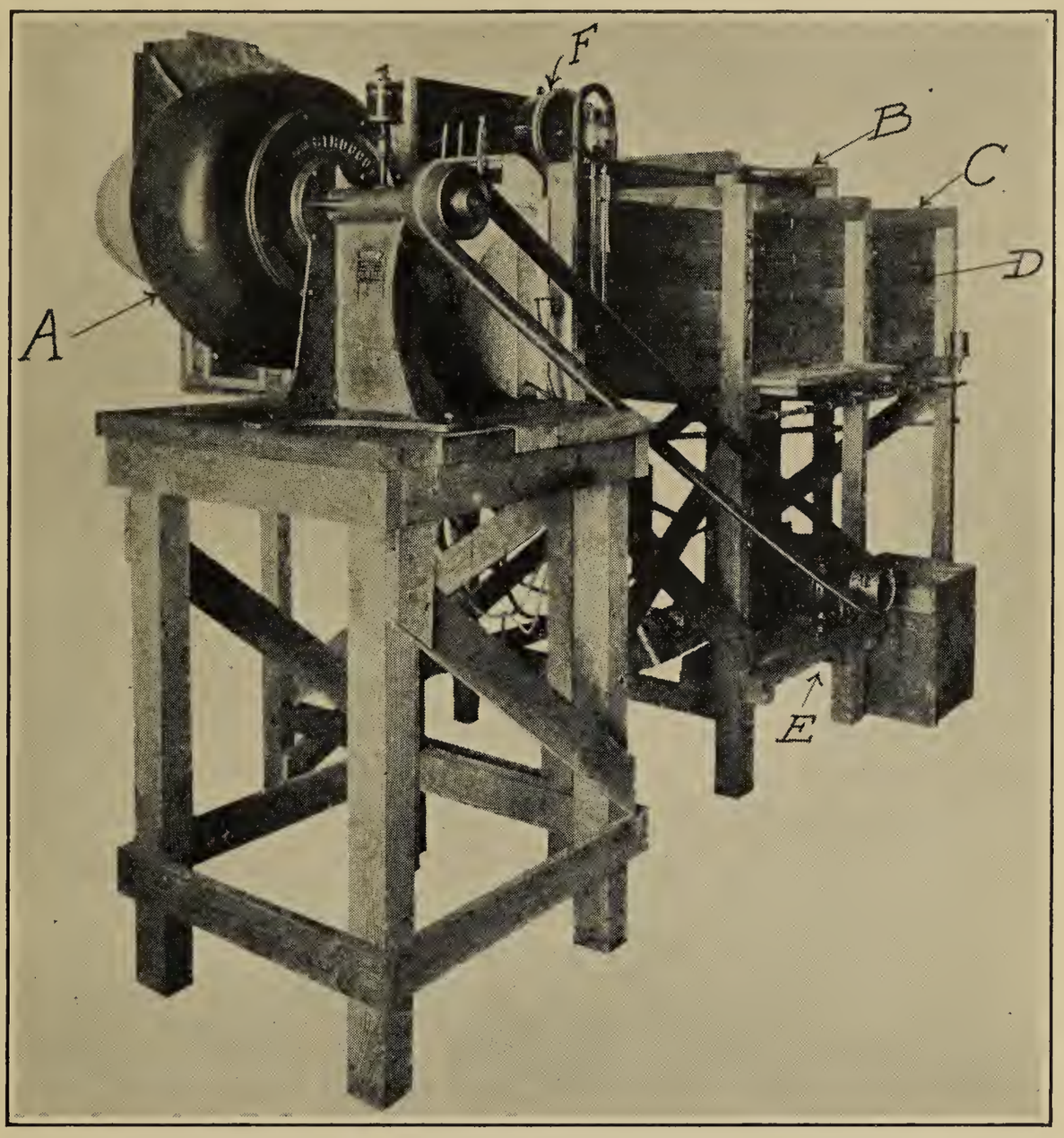

FIG. 11.—Air Blast Dehydrater in Fruit Products Laboratory, University of California. A, Multivane fan; B, Air heating chamber; C, Drying chamber; D, Tray doors, E, Motor; F, Recording thermometer.

Place equal weights on each of the four trays and sulphur 30 minutes. Dry in an air-blast dehydrater at 150°F., till each lot reaches the same degree of dryness (about 20 per cent. moisture). Plot comparatively the rates of drying from hourly weights and compare the dried samples as to color and flavor.

6. *Effect of Temperature of Air on Drying.*—Prepare three weighed trays of apples by peeling and coring, slicing or cubing and sulphuring 30 minutes. Dry one tray at 120°F., one at 150°F., and one at 200°F.,

until sufficiently dry (about 20 per cent. moisture), keeping the humidity and velocity of air as constant as possible. Record results as in 5.

7. *Effect of Humidity of Air on Drying.*—Prepare two weighed trays of cubed and blanched potatoes or cubed and sulphured pears. Dry one tray in an air-blast dehydrater at 150°F., with air of low relative humidity (below 10 per cent.). Dry the other tray with the same temperature and velocity of air, but increase the relative humidity of the air to at least 40 per cent. This may be accomplished by injecting the proper amount of steam into the heated air, measuring the humidity by a Hygrodeik or by wet and dry bulb thermometers. Record results as in Assignment XXIV 6.

8. *Effect of Velocity of Air on Drying.*—Prepare two weighed trays of cubed and blanched potatoes or cubed and sulphured apples. Dry one tray in an air-blast dehydrater at 150°F., in a vigorous blast of air (500 to 1,000 linear feet per minute over trays, as measured with an anemometer). Dry the other tray at the same temperature and humidity but in a mild flow of air (below 100 linear feet per minute) either in a natural draft evaporator or in an air-blast dehydrater with restricted air-flow. Record results as in Assignment XXIV 6.

9. *Comparison of Counter Current and Parallel Current Systems of Dehydration.*—Prepare two trays containing equal weights of apples, peeled, cored, cubed or sliced and sulphured. Dry one tray in an air-blast dehydrater, using an initial temperature of 210°F., reducing the temperature as directed below to a finishing temperature of 160°F. Dry the other tray at an initial temperature of 110°F., and a finishing temperature of 160°F. In each case estimate the total weight of moisture which must be evaporated from the apples before being considered dry. At intervals of 30 minutes weigh each tray and increase or decrease the temperature by the number of degrees obtained by multiplying the total temperature range of 50° by the percentage of water lost, referred to the weight which must be evaporated.

Example.—Five hundred grams of prepared apples, with an estimated drying ratio of 5:1, must lose 400 grams of moisture in drying. After 30 minutes at 210°F., a loss of 100 grams in weight is noted, or 25 per cent. of the total moisture to be lost. Twenty-five per cent. of 50° is 12.5°. Consequently the temperature should be reduced to 197.5°F. Similarly, if started at 110°F., a loss in weight of 10 per cent. would indicate that the temperature should be raised to 115°F.

10. *Effect of Moisture Content on Spoiling.*—Prepare three weighed trays each of one or more products such as (1) peeled, cubed and blanched potatoes, (2) peeled and sliced or cubed apples held in 2 per cent. brine for 5 minutes, (3) lye-dipped grapes or prunes, (4) peeled and sliced onions dipped in 2 per cent. brine or other materials prepared

as directed in Assignment XXV. Determine the approximate percentage of moisture in advance in a representative sample of the material to be dried as described in Assignment XXIII for apples. Calculate the weight of moisture which must be lost from each tray of material in order to obtain finished products of 15, 25, and 30 per cent. moisture, respectively, for fruits and 5, 15, and 25 per cent., respectively, for vegetables. Dry the trays at 150°F. until the predetermined weight of material has been reached in each case; note the condition or "feel" of the product and seal in tin cans or glass jars stored in a dark place. After 6 weeks or more examine for evidence of spoilage or deterioration in quality.

ASSIGNMENT XXV.—PRACTICE IN FRUIT AND VEGETABLE DRYING

Materials.—Fresh fruits and vegetables in season as suggested in Table XI.

Procedure:

1. *Dehydration.*—Prepare and dry in an air-blast dehydrater or natural-draft "Home" evaporator several lots of fruits and vegetables in season as directed in Table XI. For each lot note the weight of raw material, loss in preparation and loss in drying. Vegetables should be dried until crisp or brittle (generally below 8 per cent. moisture). All fruits should be dried to a pliable leathery texture (approximately 20 per cent. moisture), not hard and brittle, except berries and plums, which require quite thorough drying to prevent spoiling. Pack at once in insect-proof cans or cartons and store in a dry place.

2. *Sun-drying of Fruits.*—If fruits are available and climatic conditions favorable, such fruits as apricots, cherries, figs, grapes, peaches, pears and prunes may be sun-dried. The fruit should be prepared as in Table XI, except that fruit requiring sulphuring should be exposed to the fumes of burning sulphur for 3 to 4 hours. Grapes are usually sun-dried without dipping or sulphuring. Pears are usually sun-dried after merely cutting in half, sulphuring 24 to 72 hours and drying largely in the shade. After the fruit is two-thirds to three-fourths dry the trays should be stacked and the drying completed in the shade. When thoroughly dry, empty the dried fruit into boxes and allow the moisture content to equalize for several weeks. Dip in boiling water 2 minutes, drain off the surface moisture and pack in insect-proof cans or cartons. Sulphured fruits are usually resulphured for several hours after dipping and before packing in order to preserve the color.

3. *Examination of Samples.*—After at least one month's storage, note the color and flavor of each of the dried products. Make a careful comparison of samples of the same variety of fruit, one sun-dried and the other dehydrated. Examination should be made both before and after preparation for the table as in Assignment XXIII-4.

Suggestions:

1. Dried fruits may be graded in accordance with the sizes given in Table X.

2. Dried products which have become insect-infested can be fumigated to destroy insect life by placing in a tight container together with

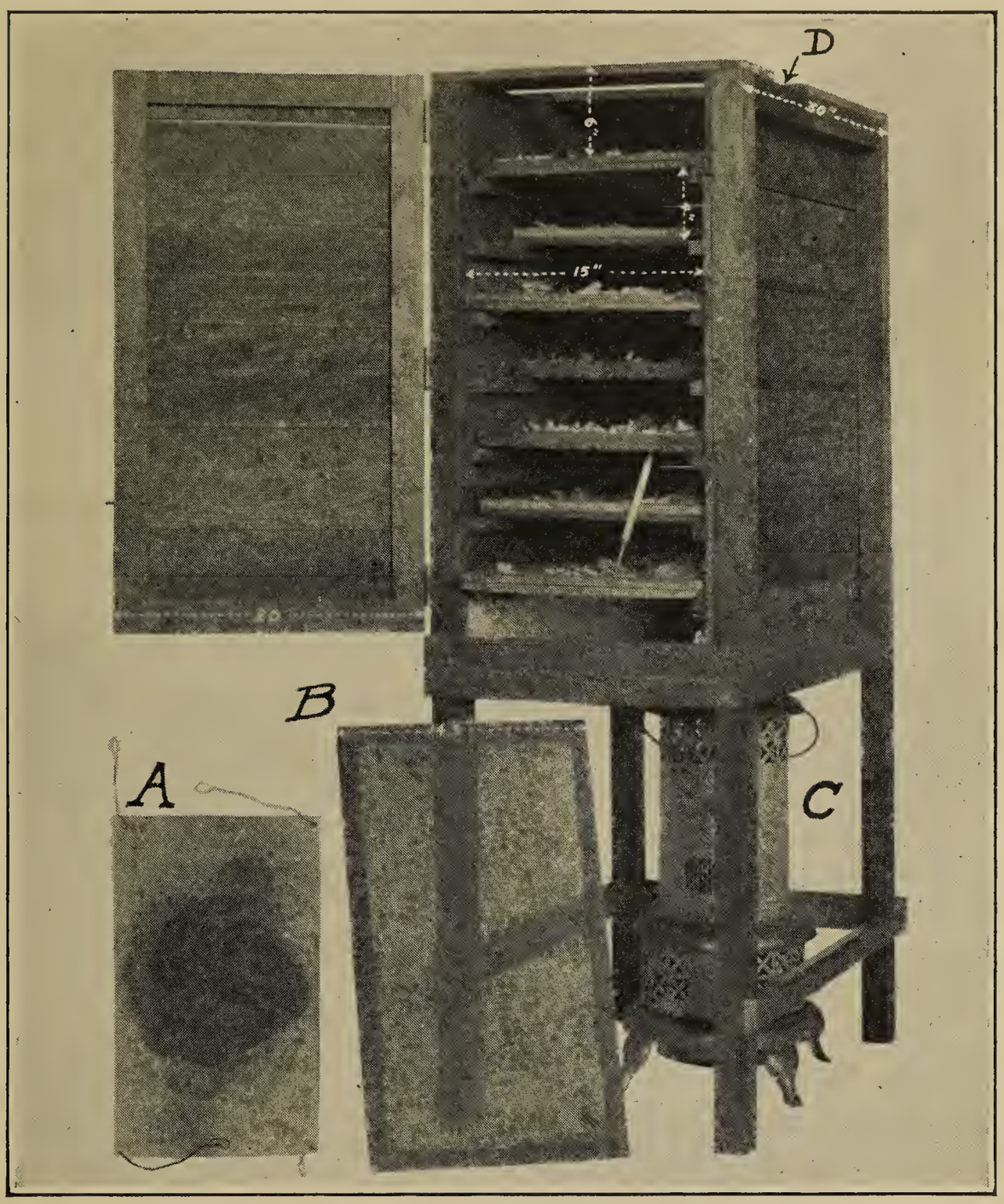

FIG. 12.—Natural draft home size evaporator. A, Heat spreader; B, Tray; C, Coa oil stove; D, Air outlet.

a pan of liquid carbon bisulphide in the proportion of 1 pound per 100 cubic feet until the carbon bisulphide has evaporated.

TABLE XI.—DIRECTIONS FOR DEHYDRATION OF FRUITS AND VEGETABLES

Product	Preparation for Tray	Lbs. per Sq. Ft. on Tray	Treatment on Tray	Safe Finishing Temperature
Apples	Peel and core, then slice or cube	2	Sulphur 30 min.	165°F.
Apricots	Halve and pit	2	Sulphur 60 min.	160°F.
Bananas	Peel, then halve lengthwise or slice crosswise	1 to 2 1 to 2	Sulphur 30 min.	165°F.
Berries, Black-, Logan- and Raspberries	Sort; wash if necessary		Sulphur 15 min. (Optional)	160°F.
Berries, Straw-	Hull and sort	1 to 2	Sulphur 30 min.	160°F.
Cherries	Dip in boiling ½ per cent soda sol.	2 to 3	Sulphur white cherries 20 min.	170°F.
Dates	Wash gently	2		140°F.
Figs	Wash thoroughly	2 to 3	Sulphur Adriatic figs 1 hr.; do not sulphur other varieties	150°F.
Grapes, Sultana, Sultanina	Dip in boiling ½ per cent lye sol., then rinse	3	Sulphur 60 min.	160°F.
Grapes, Muscat and Wine Varieties	Dip in boiling 2½ per cent lye sol., then rinse	3	Sulphur 60 min.	160°F.
Peaches	Halve and pit (peeling optional)	3	Sulphur 60 min.	150°F.
Pears	Peel; halve; core (cubing optional)	2 to 3	Sulphur 30 min.	145°F.
Plums	Halve and pit	2 to 3	Sulphur 60 min.	160°F.
Prunes	Dip in boiling ½ per cent lye sol.	3 to 4		165°F.
Beans; string	Prepare as for canning	2	Steam blanching	160°F.
Beets	Prepare as for canning; slice ¼ inch thick	2		160°F.
Cabbage	Shred; blanch 2 min. in boiling 1 per cent sodium bicarbonate sol.; rinse	1 to 2		150°F.
Carrots	Peel and cube	2	Blanch in steam 5 minutes	150°F.
Sweet Corn	Husk; blanch on cob in boiling water 10 min.; cut from cob	1 to 2		160°F.
Onion	Peel; slice ⅛ inch thick; dip in cold 3 per cent brine	1		140°F.
Peas	Prepare as for canning	1 to 2	Steam blanching (optional)	150°F.
Potatoes, Sweet	Peel; slice ¼ inch thick	1 to 2	Blanch in steam 5 min.	150°F.
Potatoes, White	Peel; slice or cube; dip in boiling water 2 min.	1 to 2	Steam blanching (optional)	150°F.
Pumpkin	Remove seeds; slice or shred into thin pieces	2	Steam blanching 4 to 5 min.	170°F.
Spinach	Wash thoroughly	1		160°F.
Tomatoes	Slice ½ inch thick, or peel and halve	1 to 2	Sulphur 30 min. (optional)	150°F.

ASSIGNMENT XXVI.—PRACTICE IN THE PREPARATION AND REFINING OF FIXED OILS

Materials.—Dry tomato seeds from Assignments IX and X, dry apricot pits 10 pounds, or dry cherry pits 5 pounds, and ripe olives (unpickled preferred) 20 pounds. Rancid oil, 1 quart.

Procedure:

1. *Preparation.—A.* Pits.—Weigh accurately about 4,000 grams of apricot pits or 2,000 grams of cherry pits. Crush the pits; separate the kernels and weigh. Grind the kernels fine with a food chopper and weigh.

B. Tomato Seeds.—Weigh the dry tomato seeds from Assignments IX and X carefully. If the seeds are not "bone dry," dry to constant weight at 140° to 150°F. Grind thoroughly with a food chopper, using the grinding attachment. Weigh the ground material.

C. Olives.—Unpickled ripe olives are best, but pickled ripe olives will answer the purpose very well. Crush the weighed fruit thoroughly in a coffee-mill or heavy sample-grinder, crushing the pits and seeds as well as the flesh. Weigh the crushed fruit.

2. *Extraction of Oil by Pressure.—A.* Fruit Kernels.—Heat the finely ground kernels to 100°C. (212°F.) in a steam box in layers about 2 inches deep between the folds of a very heavy press-cloth. While still hot place the layers or "cheeses" of material between the wooden racks of a powerful press and subject to as high pressure as is attainable with the available equipment. A pressure of at least 500 pounds per square inch is desirable. Continue the pressing until no more oil is obtained. Grind the press cake; add a small amount (about 15 per cent.) of hot water; mix well; heat to 212°F. and press a second time. Keep the oil from the two pressings separate. Allow the water and oil from the pressings to settle overnight. Separate the oil from the water by skimming or siphoning. Measure the oil obtained and reserve the press cake for Assignment XXVII.

B. Olives.—Press as directed in Assignment XXVI 2 *A*, but do not heat the fruit at any stage of the process. Do not mix the liquids from the two pressings. Allow the juice and oil to settle overnight and separate the oil from the juice by skimming or siphoning. Measure the yield of oil.

3. *Extraction by Solvent.*—Place the dry ground tomato-seeds in a Soxhlet or other continuous extractor and extract for 12 hours with pure

benzene (benzol). Remove the solvent from the oil by distillation. Weigh the residual oil and note its character.

4. *Refining and Filtering Oils from Assignment XXVI 2 and 3.*—*A.* Kernel Oils.— the oils from the first and second pressings. Note the flavor, color and odor of each. Determine the percentage of free oleic acid in a 10-gram sample by titration with N/10 sodium hydroxide as directed in Appendix, page 98. Weigh the oil and add exactly enough dry sodium carbonate (Na_2CO_3) to neutralize the free acid. (One gram of sodium carbonate will neutralize 5.32 grams of free oleic acid.) Add also 2 c.c. of water per 1,000 grams of oil and 2 per cent. by weight of finely ground bone-black or vegetable decolorizing carbon. Heat the mixture to 190° to 200° F., and pass a stream of carbon dioxide through it at this temperature for 2 hours. Allow to stand overnight at room temperature. Filter through dry filter paper and determine the yield. Note the color, flavor and odor of each. Store each oil in a tightly stoppered bottle in a dark place for 3 months and again examine for flavor, color and odor.

B. Olive Oil from Unpickled Olives.—Oil from unpickled olives will be bitter. Mix the oil from each pressing separately with three times its volume of water at 100° to 105°F. Allow to settle. Separate the oil from the water by skimming and repeat the washing and settling process until each oil is free from bitterness. Filter through dry filter paper. Store in tightly stoppered bottles in a dark place for 3 months and then note the flavor, color and odor of each.

C. Olive Oil from Pickled Olives.—Oil from pickled ripe olives is not bitter and requires no washing with water. Filter through dry filter paper; store and examine as in Assignment XXVI 4-*B*.

5. *Refining Rancid Oil.*—Rancid oil can often be rendered edible by refining as directed in Assignment XXVI 4-*A*. If this treatment fails to remove all objectionable odor and flavor, maintain the oil at a temperature of 240° to 250°F. and pass a stream of live steam through it for an hour; cool and filter.

Heating to 190°F. with 3 to 4 per cent. of finely ground Fuller's Earth and filtering will sometimes remove objectionable odors and flavors.

ASSIGNMENT XXVII.—PRACTICE IN THE PREPARATION OF ESSENTIAL OILS

Materials.—Oranges or lemons, 100 pounds. Apricot kernel or cherry kernel press-cake from Assignment XXVI. Apricot or cherry pits 3 pounds, or kernels 2 pounds.

Procedure:

1. *Essential Oil from Oranges or Lemons.*—*A.* By Pressure.—Weigh carefully about ½ box of oranges or lemons. Remove the yellow portion of the rinds, including the oil cells, by grating down to the white "rag." Grind the gratings finely and place in a heavy cloth. Press under as heavy pressure as can be obtained and collect the juice. To the pomace add an equal volume of warm water; mix and press a second time. Do not mix the two pressings. Place the juice and oil of each in a large centrifuge tube and centrifuge until the oil and juice separate into distinct layers. Separate the oil from the juice by means of a glass separatory funnel. Filter the oil through dry paper to break the emulsion and to clear the oil. Measure the yield. Mix the two lots of oil and store in a tightly stoppered bottle. If a centrifuge is not available allow the emulsions of juice and oil to settle overnight in tall tightly stoppered separatory funnels.

B. By Solvent.—Remove the oil cells from a weighed quantity of oranges or lemons by grating as directed in Assignment XXVII 1-*A*. Place the gratings in a wide-mouth glass-stoppered bottle. Add from a graduated cylinder sufficient low-boiling petroleum ether or ethyl ether to cover the product. Stopper tightly and allow to stand 8 to 10 hours with occasional agitation. Separate the solvent from the peels by heavy pressure. Separate the juice from the solvent by means of a separatory funnel. Place the solvent in a distillation flask resting in a water-bath and connect to a glass condenser. Distill at 50°C. (122°F.) until most of the solvent has been separated from the oil. Measure the volume of distillate and calculate the loss of solvent. Place the oil in a shallow beaker at room temperature until practically all odor of the solvent has disappeared. Determine the yield of oil and compare the quality with that from Assignments XXVII 1-*A* and *C*

C. By Distillation.—Place gratings obtained as in Assignment XXVII 1-*A* from a weighed quantity of lemons or oranges, in a large, heavy-

walled bottle. Fit the bottle with a two-hole rubber stopper. Insert through the stopper a ¼-inch glass tube reaching to within ¼ inch of the bottom of the bottle. Connect this tube to a source of steam, such as a large flask of boiling water. Connect the bottle containing the peels to a glass condenser fitted to a large suction flask, the latter in turn connected to a vacuum pump. Insert the bottle with the peels in a large pot of water at 180° to 190°F. and pass steam through the peels under a vacuum of 25 to 28 inches. Collect the distillate until no more oil collects in the receiving flask. Allow the distillate to stand overnight. Separate the oil by means of a separatory funnel and compare with oils from Assignments XXVII 1-*A* and *B*.

Store in glass bottles for 3 months and again compare the various samples.

2. *'Bitter Almond" Oil from Apricot or Cherry Pits.*— *A.* Preparation of Press-Cake.—Grind the press-cake from Assignment XXVI and weigh. To each 100 grams of the ground material add about 1,000 c.c. of water and boil gently for 20 minutes to extract the amygdalin.

B. Addition of Kernels.—Cool to 45°C. (113° to 115°F.) and add for each 100 grams of original dry press-cake 10 grams of *finely* ground apricot or cherry kernels, *which have not been heated previously.* The ground kernels are conveniently added after mixing in six or seven times their volume of cold water. Mix the kernels and boiled press-cake thoroughly and maintain at 45°C. for 1 hour.

C. Distillation.—Transfer the mixture to a large bottle. Arrange for steam distillation as in Assignment XXVII 1-*C*, but do not use a vacuum pump. Distill at atmospheric pressure with the bottle containing the ground press-cake, etc., immersed in boiling water. Continue the distillation until all of the bitter-almond oil has been removed, as indicated by the absence of milkiness in the condensed vapors. Place the distillate in a glass distillation flask and distill by boiling over a direct flame until one-half of the liquid has been distilled. Redistill this distillate (known as cohobation) three or four times, reducing the volume approximately one-half each time. Separate the oil from the remaining water by means of a separatory funnel and determine the yield.

Caution.—Prussic acid is formed during the process and distills with the bitter-almond oil (benzaldehyde). *Do not inhale the vapors from the still.* While the danger is not very great, unnecessary exposure to the prussic acid fumes should be avoided.

Suggestions:

1. The peeled lemons may be used for the preparation of citric acid in Assignment XXXI and the oranges may be used for juice or vinegar.

2. Bitter-almond oil (benzaldehyde) is formed from the glucoside

amygdalin, the bitter principle of the kernels in fruit pits. The reaction is induced by the enzyme, EMULSIN, which also exists in the kernels. The reaction takes place very rapidly at 45°C., as follows:

$C_{20}H_{27}NO_{11}$	$+2\,H_2O$	= HCN	$+C_6H_5CHO$	$+2C_2H_{12}O_6$
Amygdalin	+Water	= Prussic Acid	+Benzaldehyde	+Glucose

ASSIGNMENT XXVIII.—EXAMINATION OF COMMERCIAL VINEGARS

Materials.—Samples of cider, grape, malt and distilled vinegars.

Procedure:

1. *Appearance.*—Examine and compare the samples for color, clearness, sediment, flavor and odor. Hold a small sample in a test tube toward the light and examine carefully with a hand lens for presence of "vinegar eels" (minute nematode worms).

2. *Total Acid as Acetic.*—Transfer a 10-c.c. sample to a 100-c.c. volumetric flask. Dilute to mark with distilled water and mix. Determine the acid in a 10-c.c. aliquot of the diluted sample as directed on page 98. Also determine the total acid by means of a Leo Acid Tester, following the directions accompanying the apparatus.

3. *Volatile Acid as Acetic.*—Place 10 c.c. of the vinegar in a porcelain evaporating dish on a steam bath. Evaporate almost to dryness. Add 20 c.c. of water and evaporate again almost to dryness. Repeat additions of water and evaporations at least five times. Take up the residue in water and titrate with N/10 sodium hydroxide. Report as fixed acid in terms of acetic acid. Total acid minus fixed acid gives the volatile acid as acetic acid.

4. *Extract.*—With a pipette place 25 c.c. of the vinegar in a tared evaporating dish about 200 mm. wide. Evaporate to a syrupy consistency over a steam bath. Dry 1 hour at 100°C. in a drying oven and weigh. Calculate grams of extract per 100 c.c.

5. *Alcohol.*—Place 200 c.c. of the sample in a 500-c.c. distillation flask. Neutralize with concentrated sodium hydroxide, using litmus paper as an indicator.

Distill about 95 c.c. into a 100-c.c. volumetric flask. Dilute to mark. Determine the specific gravity by means of a hydrometer, Westphal balance or pycnometer at 15½°C.

From the alcohol table in "Food Analysis" by Leach determine the corresponding alcohol content of the distillate. This figure divided by two gives the alcohol content of the vinegar.

Alcohol in excess of ½ per cent. indicates incomplete acetic acid fermentation.

6. *Sugar.*—Determine total sugar after inversion as directed in the Appendix, page 100.

Suggestions:

1. *Vinegar Standards.—A.* Pure cider vinegar contains in each 100 c.c. not less than 4 grams of acetic acid, 1.6 grams of extract (of which not more than 50 per cent. is reducing sugars), and .25 grams apple ash.

Diluted cider vinegar must contain not less than 4 grams of acetic acid per 100 c.c., but need not conform to the other standards if labeled "diluted."

B. Malt vinegar contains in each 100 c.c. not less than 4 grams of acetic acid, 2 grams of solids and 0.2 grams of ash.

C. Wine vinegar or grape vinegar contains in 100 c.c. not less than 4 grams of acetic acid, 1.0 gram of grape solids and 0.13 grams of grape ash.

D. Distilled vinegar, spirit vinegar or grain vinegar is made by the acetification of dilute alcohol and contains in 100 c.c. not less than 4 grams of acetic acid.

An exact interpretation of the above standards would require that the 4 grams of acid per 100 c.c. be all acetic acid. In practice, however, the total acid is determined and calculated as acetic, although part of the total acid may be due to other organic acids. The addition of mineral acids to vinegar is prohibited.

2. *Definition of "Grain Strength."*—The trade usually designates the strength of vinegar by "grains" instead of in percentage. A "40-grain vinegar" contains 4 grams of total acid per 100 c.c. calculated as acetic acid. That is, "10 grains" is equivalent to "1 gram of acid as acetic per 100 c.c."

ASSIGNMENT XXIX.—EXPERIMENTAL PREPARATION OF CIDER VINEGAR

Materials.—Twenty pounds of apple culls.

Procedure:

1. *Preparation of Pure Yeast Starter.*—Obtain a pure culture of cider yeast (*Saccharomyces ellipsoideus* or *S. malei*) on agar. Add a small amount of sterile cider. Incubate 3 to 4 days at 80° to 90°F. Transfer the actively fermenting culture to 500 c.c. of sterile cider in a cotton-plugged flask and incubate at 80° to 90°F. until in active fermentation.

2. *Crushing and Pressing.*—Extract the juice from a weighed amount of apple culls as directed in Assignment XIII. Determine the yield, acidity of the juice, and Balling degree.

3. *Alcoholic Fermentation.*—Divide into two equal portions and place each half in a 1-gallon stoneware crock. Place both crocks in an incubator at 80° to 90°F., or in a warm room.

A. Spontaneous Fermentation.—Cover one crock with cheese cloth and allow to undergo fermentation without addition of yeast.

B. Pure Yeast Fermentation.—To the second crock of juice add the actively fermenting pure yeast culture from Assignment XXIX 1 at the rate of 50 c.c. per 1,000 c.c. of cider. Mix thoroughly.

Determine the Balling degree of each lot daily until fermentation ceases. Fermentation will usually be complete in 2 to 3 weeks. Examine samples of each juice under the high power of the microscope on the second and third days of fermentation and make sketches of micro-organisms found.

Determine the alcohol and sugar in the fermented juices as directed in Assignment XXVIII. Calculate the yield of alcohol per gram of sugar fermented in each case.

4. *Acetic Fermentation.*—Decant the fermented liquids from the yeast sediment and strain through several thicknesses of cheese cloth. Rinse the containers used for alcoholic fermentation and return the fermented liquids to them.

Allow lot 3-*A* (spontaneously fermented juice) to remain untreated.

To lot 3-*B* add one-fourth its volume of bulk cider vinegar (not pasteurized bottled vinegar).

Determine the acidity of each lot. Cover both crocks with cloth to exclude vinegar flies and place in an incubator at 80° to 90°F. or in

a warm room. Determine the acidity of each at intervals of one week until there is no longer any increase in acidity.

Determine the residual alcohol as directed in Assignment XXVIII. Calculate the amount of alcohol oxidized during acetic fermentation.

5. *Clarification.*—*A.* Filtration.—Determine the rate of filtration of 100 c.c. portions of each vinegar through a small filter paper. To 100 c.c. portions add 2 grams of "Filter cel" or other infusorial earth, and to a third 100-c.c. portion of each add 4 grams of this material. Mix well and again determine the rate of filtration of each. Compare the clearness and flavor of the filtrate from each lot.

B. Clarification with Isinglass.—Prepare a 2 per cent. solution of Russian isinglass (fish glue) or other good grade of isinglass by soaking 2 grams of the material in 100 c.c. of vinegar for 24 hours and grinding in a mortar until dissolved.

To 100-c.c. lots of each vinegar add the following amounts of isinglass by means of this solution:

(1) 5 grams per hectoliter.....0.25 c.c. per 100 c.c.
(2) 10 grams per hectoliter.....0.50 c.c. per 100 c.c.
(3) 20 grams per hectoliter.....1.00 c.c. per 100 c.c.
(4) 40 grams per hectoliter.....2.00 c.c. per 100 c.c.
(5) 80 grams per hectoliter.....4.00 c.c. per 100 c.c.

Shake thoroughly and allow to stand 48 hours. Compare results. To lots which have not settled add 1,000 grams Spanish Clay per hectoliter as directed in 5-*C* and note results.

C. Spanish Clay.—Prepare a 10 per cent. suspension of Spanish Clay as directed in Assignment XII-6-*C*. To 100-c.c. lots of each vinegar add the following amounts of this clarifying agent (dry basis):

(1) 100 grams per hectoliter..... 1 c.c. per 100 c.c.
(2) 200 grams per hectoliter..... 2 c.c. per 100 c.c.
(3) 400 grams per hectoliter..... 4 c.c. per 100 c.c.
(4) 800 grams per hectoliter..... 8 c.c. per 100 c.c.
(5) 1600 grams per hectoliter.....16 c.c. per 100 c.c.

Allow to stand 48 hours and compare results.

6. *Pasteurizing.*—Combine the clear vinegar from 4-*A*, 4-*B*, and 4-*C*, keeping the two original lots of vinegar separate. Bottle and seal with crown caps. Pasteurize one-half of each lot at 140°F. for 20 minutes. Place all bottles in an incubator at 80° to 90°F., or in warm rooms for several months. Compare the clearness of pasteurized and unpasteurized samples.

Suggestions.—Data from alcoholic and acetic fermentations should be plotted on coordinate paper in order to indicate the relative rates and completeness of fermentation.

ASSIGNMENT XXX.—PRACTICE IN THE PREPARATION OF FRUIT VINEGARS

Materials.—Cull fruit, such as apples, oranges, grapes, pears, peaches or prunes, 50 pounds.

Procedure:

1. *Preparation of Yeast Starter.*—Prepare about 1,000 c.c. of pure cider yeast starter as directed in Assignment XXX-1.

2. *Preparation of Fruit.*—*A.* Juicy Fruits.—Crush and press juicy fruits, such as oranges, grapes and apples, as directed in Assignment XIII. Record the weight of the fresh fruit and pomace and the volume of juice. Determine the acidity and Balling degree of each juice and place each in a stoneware crock. Dry the pomace in an air-blast dehydrater and determine the yield of dried material.

B. Pulpy Fruits.—Thoroughly crush a pulpy fruit, such as peaches, pears or prunes, into a stoneware crock. Press out a small quantity of the juice and determine the acidity and Balling degree. If the Balling degree exceeds 20° add a calculated amount of water to reduce it to 20°. Record the weight of fresh fruit used. Do not press until after preliminary fermentation has taken place.

3. *Fermentation.*—*A.* Juice.—To each 1,000 c.c. of fresh juice add 50 c.c. of an actively fermenting pure yeast culture. Mix thoroughly and cover the crock with a cloth to exclude vinegar flies. Store in a warm place at 80° to 90°F. and allow to stand until fermentation ceases. Take the Balling degree of each fermenting juice daily and plot the rate of fermentation. Fermentation should be complete within 15 days.

B. Pulpy Fruits.—To the crushed pears or other pulpy fruit add 50 c.c. of actively fermenting pure yeast starter per 1,000 grams of fruit. Mix thoroughly and cover the crock with cloth. Stir vigorously twice daily until the fruit is thoroughly softened by fermentation (usually 4 to 5 days). Determine the Balling degree daily. Press out the juice, weigh the pomace and measure the volume of juice obtained. Allow the fermentation to proceed as in 2-*A* until there is no further reduction in Balling degree. Record the Balling degree and plot the rate of fermentation.

4. *Clearing the Fermented Juice.*—Separate the fermented juice from the yeast sediment and filter it through a juice filter or filter paper.

5. *Dilution and Addition of Acid.*—Determine the total acid and

alcohol content of the fermented juice as directed in Assignment XXVIII. If the alcohol is in excess of 6 per cent. reduce it to this percentage by the addition of a calculated amount of water.

To each 1,000 c.c. of the liquid add 250 c.c. of strong unpasteurized fruit vinegar.

6. *Acetification.*—Store the filtered and acidified liquid at 80° to 85°F. in a stoneware crock covered with cheese cloth. Determine the total acidity weekly until there is no longer any increase. Plot the rate of acetic fermentation.

7. *Clearing and Bottling the Vinegar.*—Filter the vinegar and measure its volume. Calculate the yield of vinegar in gallons per ton of fresh fruit.

Bottle the vinegar in crown-finish bottles and seal with crown caps. Pasteurize as directed in Assignment XXIX-6.

Suggestions:

1. Dried unsulphured fruits may be used for the preparation of vinegar if soaked until soft in sufficient water to reduce the sugar percentage to 20 and then crushed and fermented as directed for pulpy fruits.

2. Potatoes (sweet or white) may be used in the same manner as pulpy fruits for vinegar making if first thoroughly cooked in a steam retort at 5 pounds pressure, to gelatinize the starch, and then heated at 60°C. (140°F.) with 5 per cent. of ground barley malt until the starch is converted to sugar. Complete conversion of the starch to sugar is shown by the absence of blue color when a drop of the "mash" is mixed with a drop of dilute iodine solution.

ASSIGNMENT XXXI.—PRACTICE IN THE PREPARATION OF SAUERKRAUT AND PICKLES

Materials.—Cabbage 25 pounds and cucumbers 30 pounds.

Procedure.

1. *Sauerkraut.*—Select only mature sound heads of cabbage.

A. Preparation.—Cut in quarters and remove the core. Shred by hand with a large knife or by means of a vegetable slicer.

B. Salting.—Mix the shredded cabbage thoroughly with fine salt at the rate of 2 ounces (about 60 grams) of salt for each 5 pounds of cabbage. Pack firmly, but not too tightly, in a 3-gallon stoneware crock. Cover with a clean table-plate or circular piece of board slightly smaller in diameter than the crock. Place a heavy weight on the cover so that after 24 hours the level of the brine formed by the salt and cabbage juice is above the cover. Do not use lime stone.

C. Fermentation.—Place the crock in a warm room or in an incubator, preferably at about 86°F. Remove scum occasionally. When fermentation is complete, usually 6 to 8 days, determine the acidity of the brine by titration of a 10-c.c. sample as directed in Appendix, page 98.

D. Canning.—Fill two glass-top fruit-jars completely with the finished sauerkraut; add brine from the fermentation crock to fill the jars to overflowing. Seal and store without sterilization.

Place the remainder of the kraut into cans, completely full. Add brine from the fermentation crock to fill the cans completely, or if there is insufficient fermented brine, add a 3 per cent. brine. Exhaust 5 minutes in live steam, seal and sterilize 25 minutes in boiling water. Store and compare with unsterilized samples after one month.

2. *Salt Pickles.*—*A.* Preparation.—Wash the fresh cucumbers and place about 12 pounds in a 4-gallon crock. Cover with a 10 per cent. brine (40° salometer). Cover as directed for sauerkraut and weight the cover sufficiently to keep the cucumbers submerged in the brine.

B. Fermentation.—Store at room temperature. At weekly intervals for a period of 6 weeks place ¼ pound of salt on the cover for each 6 quarts of brine. Salt placed on the cover dissolves gradually and is distributed evenly in the brine. The surface of the brine must be skimmed occasionally to prevent putrefaction and loss of acid. When

the curing process is complete the cucumbers should be firm in texture and should have changed in appearance from opaque white to translucent. The bright green color of the fresh cucumbers becomes an olive green. Six to eight weeks are usually required for proper curing. Cucumbers in this condition are known as "salt stock" and are used in the preparation of sour or sweet pickles as directed in Assignment XXXI 3 and 4. Salt stock will keep indefinitely if the brine is skimmed frequently to prevent excessive growth of film yeast.

3. *Processing Salt Pickles.—A.* Removal of Salt.—Place the salted cucumbers from Section 2 in a large pot. Cover with water at about 120°F. Place the pot on a hot plate and maintain at this temperature for 10 to 12 hours. Repeat this extraction until most of the salt is removed as indicated by the taste.

B. Grading.—Grade the cucumbers into two sizes. Use the large size for sour pickles and reserve the small size for sweet pickles.

4. *Sour Pickles.—A.* Addition of Vinegar.—Cover the large pickles from Assignment XXXI 3 with distilled vinegar of 4 to 6 per cent. acetic acid. Allow to stand until the vinegar has penetrated the pickles thoroughly.

B. Canning.—Fill one glass jar with the pickles and vinegar. Seal but do not sterilize.

Put the remainder of the pickles into double-lacquered cans. The cans should be filled completely with vinegar. Exhaust in live steam 12 to 15 minutes. Seal hot. No further sterilization is required.

5. *Sweet Pickles.—A.* Preliminary Treatment.—Cover the small pickles from Assignment XXXI 3 with distilled vinegar containing 4 to 4½ per cent. acetic acid and allow to stand about 10 days. Drain the vinegar and in it dissolve 3 pounds of sugar per gallon, in which immerse the pickles again for about one week.

B. Addition of Spices.—Remove the vinegar and add about 20 grams of mixed whole spices (obtainable from any grocery store) per gallon. The spices most commonly used are black pepper, cayenne pepper, cloves, cinnamon, celery seed, caraway seed, dill seed, mustard, allspice, cardamom, bay leaves and coriander. Heat to the simmering point for about ½ hour. Add fresh vinegar to replace that lost by evaporation, strain out the spices, and add sugar at the rate of 3 pounds per gallon. Cover the pickles with the spiced vinegar and allow to stand about one week. Can as directed in Assignment XXXI 4.

6. *Dill Pickles.*—Select and wash large fresh cucumbers uniform in size.

A. Packing.—Place a layer of dill herb and ½ ounce of mixed dill pickle spices in the bottom of a 4-gallon crock. Fill the crock within 2 or 3 inches of top and add another layer of dill and ½ ounce of spices

B. Brining.—Cover with a brine consisting of 1 pound of salt and 1½ pints of vinegar to 2½ gallons of water. Cover with a weighted plate or board.

C. Fermentation.—Store at a temperature of about 86°F. and skim occasionally. Fermentation should be complete within 10 to 14 days.

4. *Canning.*—Can as directed in Assignment XXXI 4.

Suggestions.—Small (pearl) onions, cauliflower, green tomatoes, and string beans are prepared for pickling by 6 to 8 weeks' storage in brine strong enough (15 per cent. salt) to prevent fermentation. They may then be converted into sour or sweet pickles as directed in Assignment XXXI 4 and 5 and mixed in any desired proportion with cucumber pickles.

ASSIGNMENT XXXII.—PRACTICE IN THE PREPARATION OF FRUIT ACIDS

Materials.—Twenty-five pounds of lemon or lime culls. One-half pound of crude grape argol; i. e., crystalline sediment from grape juice or wine.

Procedure:

1. *Citric Acid.*—*A.* Extraction of Juice.—Crush and press the juice from 25 pounds of lemon culls. To the pomace add 4,000 c.c. of water. Mix well; press a second time. Mix the liquids from the two pressings. Weigh the pomace and measure the volume of the combined extracts.

B. Fermentation.—Place the juice in a stoneware crock and add a cake of compressed yeast. Mix the yeast thoroughly with the juice. Cover with a cloth and allow to ferment at room temperature one week.

C. Filtration.—Add 2 grams of finely pulverized "Filter Cel" per 100 c.c. of fermented juice and bring to boiling. Allow to settle for 24 hours. Decant off the clear liquid and filter if necessary. Filter the cloudy liquid and sediment through coarse filter paper and combine the clear liquids. Measure the volume.

D. Neutralization.—Determine the percentage of citric acid in the juice by titration as directed in Appendix, page 98. Calculate from the following reaction the amount of precipitated chalk (calcium carbonate) required to neutralize the acid, and add 5 per cent. in excess to the liquid.

Citric Acid	+ Calcium Carbonate	= Calcium Citrate	+ Water	+ Carbon Dioxide
$2C_6H_8O_7$	$+3CaCO_3$	$=Ca_3(C_6H_5O_7)2$	$+3H_2O$	$+3CO_2$
384 Gms.	+300 Gms.	=474 Gms.	+54 Gms.	+132 Gms.

Mix well. Boil until evolution of carbon dioxide gas ceases. Filter through filter paper while still boiling hot. Wash the precipitate on the filter with a small amount of boiling water.

E. Decomposition of Calcium Citrate.—Transfer the precipitate to a large beaker and add sufficient water to make a thin paste.

Add sulphuric acid (20 per cent. solution) slowly with constant stirring until a drop of the liquid placed on a piece of methyl violet indicator paper changes the color of the indicator to blue. To prepare the indicator paper dip small strips of filter paper in dilute methyl violet solution and allow to dry at room temperature.

F. Filtration.—Filter through filter paper to remove calcium sulphate. Wash precipitate with a small amount of cold water.

G. Concentration.—Place the filtrate in a large, heavy-walled flask connected to a condenser and vacuum pump. Concentrate by boiling *in vacuo* to a density of 20° to 25° Baumé (test made at 50°C.). Transfer to a large beaker and allow to cool to room temperature and settle. Filter off the precipitated calcium sulphate and return the filtrate to the vacuum flask. Concentrate *in vacuo* to 37° to 39° Baumé (test made at 50°C.).

H. Crystallization.—Transfer the liquor to a heavy-walled beaker or small stoneware jar and allow to cool and crystallize for one week. Stir two or three times daily.

I. Separation from Mother Liquor.—Separate the crystals from the mother liquor by draining through cloth. This gives "brown crystals." The mother liquor still contains recoverable citric acid, but in this assignment may be neglected and the mother liquor discarded.

J. Decolorization.—Dissolve the drained crystals in a small amount of distilled water and dilute to 20° to 25° Baumé. Add 3 per cent. by weight of finely ground vegetable decolorizing carbon such as "Noirit" or "Eponit." Stir and heat to boiling. Filter free of carbon. A water-white filtrate should be obtained. Wash the carbon on the filter with a small amount of hot water and combine the filtrates.

K. Concentration of decolorized liquor.—Concentrate *in vacuo* to 36° to 37° Baumé (test made at 50°C.) and allow to crystallize as directed in Assignment XXXII 1-*I.*

L. Drying.—Separate the crystals from the mother liquor and allow to dry in the air several days. Weigh and calculate the yield of citric acid in pounds per ton of fresh fruit. The mother liquor contains recoverable citric acid but in this assignment may be discarded.

2. *Cream of Tartar.*—*A.* Dissolving Cream of Tartar.—Weigh 200 grams of finely ground crude "argol" and mix with about 5,000 c.c. of distilled water. Boil 10 minutes and filter through cloth until fairly clear.

B. Concentration.—Concentrate by boiling to about 1,000 c.c.

C. Crystallizing.—Set aside in a cool place and allow to crystallize for 4 to 5 days. Separate crystals from mother liquor by decantation.

Concentrate the mother liquor *in vacuo* to about 200 c.c. and allow to crystallize as above. Combine the two lots of crystals and discard the mother liquor.

D. Decolorizing.—Dissolve the crystals in about 5,000 c.c. of water and add 1 per cent. by weight of vegetable decolorizing carbon. Boil 5 minutes and filter through paper.

E. Concentration and Crystallizing.—Concentrate *in vacuo* to about 1,000 c.c. Pour into a beaker and allow to crystallize several days. Remove the mother liquor and dry the crystals in the air. Concentrate the

mother liquor to about 200 c.c., crystallize; separate the crystals and dry in the air. Weigh the air-dry crystals from both lots and calculate the total yield in percentage.

Suggestions:

1. Tartaric acid may be prepared from the crude argol or cream of tartar in a method analogous to that for citric acid.

2. Tartaric acid may be prepared synthetically from carbon dioxide and water by a patented electrolytic process.

3. Crude argol may be obtained from any grape-juice factory or cream-of-tartar refinery.

ASSIGNMENT XXXIII.—PRACTICE IN OLIVE PICKLING

Materials.—Thirty-five pounds of ripe olives of a commercial variety such as Mission, Manzanillo or Sevillano. Ten pounds of green olives, preferably Sevillano or Manzanillo.

Procedure:

1. *Grading.*—Grade the olives by screens or by hand, as suggested in Table XII. Record the weight of each size.

2. *Storage.*—If the olives can not be pickled immediately after grading place them in a brine of 10 per cent. salt. Store in a cool place. If the olives float, place a weight upon them to hold them beneath the surface; or seal in glass jars. Olives after storage in brine must be soaked in several changes of water for 24 hours before pickling.

3. *Pickling Ripe Olives by Usual Commercial Process.*—*A.* First Lye.—Prepare a lye (sodium hydroxide) solution containing for Mission olives 2 per cent. sodium hydroxide and for Manzanillo and Sevillano varieties 1½ per cent. Cover the olives in a crock with this solution at a temperature of 65° to 75°F. Allow to remain until the lye has barely penetrated the skin of the fruit as evidenced by discoloration of the skin and flesh. It should not be allowed to penetrate more than 1/16 inch into the flesh. This will, at the temperature given above, usually require 3 to 5 hours. Discard the lye.

B. First Exposure.—Allow the olives to remain exposed to the air until an even black color is obtained. Stir the olives at least three times daily. Three to five days' time will be required.

C. Subsequent Lye Treatments and Exposures.—Cover the olives with a 0.5 per cent. lye solution and allow to penetrate about one-fourth way to the pit. A drop of phenolphthalein indicator placed on the cut surface of the fruit will indicate the depth of penetration of the lye. Remove and discard the lye. Expose the olives to the air 24 hours. Cover again with a 0.5 per cent. lye solution and allow to penetrate about ¾ to pit. Remove and discard the lye. Expose the olives again to the air for 24 hours. Cover the olives again with a 0.5 per cent. lye solution and allow it to penetrate completely to the pit. Remove and discard the lye. Expose the fruit again for 24 hours to the air.

D. Washing.—Cover the olives with water and change the water twice or three times daily until all lye is removed from the flesh of the

fruit. (This is determined by applying a drop of phenolphthalein to the cut surface; or by taste).

E. Brining.—Place the olives in a 3 per cent. salt brine for two days.

F. Filling and Exhausting.—Fill cans with the olives, after careful sorting. Add hot 3 per cent. brine and exhaust in steam for 6 minutes.

G. Sterilization.—Seal and sterilize in a retort at 240°F. for 40 minutes.

4. *Pickling Ripe Olives by the Aerated Water Process.*—Put ripe olives in a 3-gallon stoneware crock until about two-thirds full. Cover with a 1½ per cent. lye (sodium hydroxide) solution. Insert a glass tube to the bottom of the container and connect the tube to a supply of compressed air. Pass air through the liquid vigorously until the lye has penetrated the skin of the olives and has entered the flesh of the olives to a depth of 1/32 inch. Remove the lye and replace it with water. Continue the aeration of the liquid, changing the water twice daily. At the end of two days cover the olives with a ½ per cent. lye solution and allow it to penetrate about one-half way to the pit, aerating the liquid continuously during this treatment. Replace the lye solution with water and continue the aeration for another 24 hours. Again add a ½ per cent. lye solution and allow it to penetrate nearly to the pits of the fruit. Replace it with water for 24 hours. Finally place a ½ per cent. lye solution on the olives and allow it to penetrate to the pit. Replace the lye with water, which should be changed twice daily until the olives are free from lye. Cover the olives with a 3 per cent. salt solution and allow them to stand 24 hours. During all lye, water and brine treatments continue the aerating process. Can and sterilize the pickled olives as directed in Assignment XXXIII 3. Compare the flavor and general quality with the olives from Assignment XXXIII 3.

5. *Pickling Ripe Olives by the Greek Process.*—Use large thoroughly ripe olives. Mix the olives with one-fourth their weight of coarsely crushed rock-salt in a wooden box equipped with a perforated bottom to permit escape of brine formed during pickling. Cover the olives with a layer of crushed rock-salt about ½ inch thick, this salt being in addition to that mixed with the fruit as directed above. Allow the mixture of olives and salt to stand in a cool place until the fruit has developed the characteristic wrinkled appearance of commercial Greek olives and until most of the bitterness has disappeared. The time usually required is about 6 weeks. The salt and olives should be thoroughly mixed once a week during the curing period. Pack the finished product in jars or small wooden boxes with about 10 per cent. of its weight of coarsely crushed rock-salt.

6. *Green Olives by Fermentation Process.*—Use hard green olives which have attained full size. The Sevillano olive is best for the prepa-

ration of green olive pickles. Cover the olives in a stoneware crock with a 1½ per cent. lye solution (sodium hydroxide). Allow the lye to penetrate about three-fourths the distance to the pits of the fruit. Remove and discard the lye. Cover the olives immediately with water twice daily until the fruit is free from lye. Place the olives in a small wooden keg or wooden pickle bucket of convenient size or in a large fruit jar. Fill the container completely with a brine of 9 per cent. salt and containing 1/10 of 1 per cent. acetic acid from vinegar. Seal and set aside at room temperature until the olives have developed the flavor desired. Two to three months' time will usually be sufficient for the completion of the necessary lactic acid fermentation.

Suggestions.—The relation of the diameter of olives to the commercial size grades is shown by the following table:

TABLE XII.—RELATION OF SIZE GRADES AND DIAMETER OF RIPE OLIVES

Grade	Number Per Pound*	Diameter in Inches	Grade	Number Per Pound*	Diameter in Inches
Small.....	120–135	9/16	Mammoth..	65–75	13/16
Medium.....	105–120	10/16	Giant.....	55–65	14/16
Large.....	90–105	11/16	Jumbo.....	45–55	15/16
Extra Large...	75– 90	12/16	Colossal....	35–45	16/16

* The relatively wide range in "number per pound" is necessary to include all varieties of olives of different shapes.

ASSIGNMENT XXXIV.—PRACTICE IN THE PREPARATION OF MUSEUM SPECIMENS

Materials.—Freshly gathered specimens of fruits and vegetables as perfect in shape, color and condition as possible. Perfect specimens of large size and free from blemishes give the best results.

Procedure:

1. *Green Colored Products* (such as artichokes, string beans, peas, spinach, green leaves, cucumbers, green almonds, and hard green fruits). The preservation of the green color (chlorophyll) of plant tissues depends upon fixation of the color with copper salts.

A. Fixation of Chlorophyll Color.—Immerse in a 5 per cent. copper sulphate solution until the color has been fixed as indicated by a definite deepening of the tint. This will require 24 hours or less.

B. Storage Solution.—Remove the specimens from the copper sulphate solution, rinse in running water for 2 to 3 hours to remove excess copper sulphate. Rinse in distilled water and store in a glass jar filled with a solution containing 1 ounce of 6 per cent. sulphurous acid per gallon of distilled water. The jar should be well sealed to prevent loss of the sulphurous acid and the solution renewed once every 6 months.

2. *Tomatoes and Red Peppers.*—Store specimens of uniform red color and firm texture in the following solution:

Distilled water	1 gallon	Sulphurous acid 6 per cent. solution	1/8 ounce
Salt	2 ounces	Potassium nitrate	1/4 ounces
Formalin	1/4 ounce	Glycerine	8 ounces

Green leaves should be fixed separately in 5 per cent. copper sulphate solution before placing in the above solution.

3. *White Vegetables* (corn on cob, cauliflower, asparagus, dry onions, celery, turnips, summer squash, etc.) can be preserved in the following solution:

Distilled water	1 gallon	Potassium nitrate	1 ounce
Sulphurous acid 6 per cent. solution	1 ounce	Salt	3 ounce

Copper sulphate to give a faint green solution.

4. *Citrus Fruits* (oranges, grapefruit, lemons, and limes) retain their color and form satisfactorily in the following solution:

Water	1 gallon	Sulphurous acid 6 per cent. solution	1/2 ounce
Formalin	1/8 ounce	Boric acid	1 ounce

Copper sulphate to give a faint green solution.

5. *White Grapes, Ripe Pears and Yellow Apples.*—Store in the following solution. No preliminary fixation of color is necessary.

Distilled water	1 gallon	Boric acid	1 ounce
Potassium nitrate	1/8 ounce	Glycerine	6 ounces

Copper sulphate to give a faint green solution.

6. *Black Grapes and Other Black Fruits* (such as ripe prunes, Damson plums, black cherries, etc.).—Store in the following solution. No preliminary fixation of color is necessary.

Distilled water	1 gallon	Boric acid	1 1/2 ounces
Formalin	3 ounces	Salt (Na Cl)	3 ounces
Glycerine	6 ounces		

7. *Berries, Peaches, Apricots, Red or White Cherries, Red Grapes and Other Red Fruits.*—Fix the color in the following solution until the red color has changed to a uniform purple, but do not prolong the treatment beyond this point; 24 to 36 hours is usually sufficient.

Distilled water	1 gallon	Formalin	1/2 ounce
Sulphurous acid 6 per cent. solution	1 ounce	Glycerin	10 ounces

When the color has been fixed, store the specimens in the following solution:

Distilled water	1 gallon	Sulphurous acid 6 per cent. solution	1 ounce

Renew this solution once each 6 months.

Suggestions:

1. Except with specimens of green color, leaves should be fixed separately from the fruit specimens in 5 per cent. copper sulphate solution. The fruit after fixation in a suitable solution can be tied to the branches by means of thread. Delicately tinted fruits if placed in 5 per cent. copper sulphate solution usually develop an undesirable brown color, and green leaves if placed directly in the solutions used for fruits either become brown in color or bleached.

2. In all cases where glycerine is recommended, it may be replaced by cane sugar to increase the Balling degree of the liquid to approximately that of the juice of the fruit. For grapes this is about 20° to 22° Balling and for most other fruits 12° to 15° Balling.

METHODS OF ANALYSIS

1. Preparation of Standard Acid and Alkali Solutions:

A. Tenth-normal Hydrochloric Acid.—Dilute 8.6 c.c. of concentrated hydrochloric acid C.P. to 1,000 c.c. with distilled water in a volumetric flask.

Weigh exactly 2.6500 grams of anhydrous sodium carbonate C.P. in a small beaker and wash into a 500-c.c. volumetric flask with distilled water and dilute to exactly 500 c.c. Mix thoroughly. The distilled water should be freed from carbon dioxide by previous boiling and cooling.

Pipette exactly 20 c.c. of this N/10 sodium carbonate solution into a beaker or flask, add a few drops of methyl orange indicator (0.2 grams in 500 c.c. of distilled water), and titrate with the approximately N/10 hydrochloric acid measured from a burette until the color suddenly changes from yellow to orange.

If less than 20 c.c. of the acid are required to neutralize 20 c.c. of the N/10 sodium carbonate, the acid is stronger than N/10 and should be diluted with sufficient distilled water to reduce its strength to exactly N/10.

Example.—If 18.9 c.c. of the hydrochloric acid neutralized 20 c.c. N/10 sodium carbonate and 945 c.c. of the acid remained for dilution $\frac{945}{18.9} \times (20.0 - 18.9) = 55$ c.c. of water required to dilute the hydrochloric acid to N/10. The strength of the acid adjusted to N/10 should be checked by a second titration against the N/10 sodium carbonate.

B. Tenth-normal Sodium Hydroxide.—Dissolve 4.5 grams of dry sodium hydroxide C.P. in distilled water free of carbon dioxide and dilute to 1,000 c.c.

Pipette exactly 20 c.c. of this solution into a beaker or flask, add a few drops of methyl orange and titrate with the N/10 hydrochloric acid as in *A* above.

If more than 20 c.c. of N/10 hydrochloric acid are required, the sodium hydroxide is stronger than N/10 and should be diluted with distilled water to reduce its strength to N/10.

Example.—If 21.1 c.c. of N/10 hydrochloric acid were required to neutralize 20 c.c. of the sodium hydroxide and 980 c.c. of the alkali remained for dilution $\frac{980}{20} \times (21.1 - 20.0) = 53.9$ c.c. of water required to dilute the alkali to exactly N/10. Check the adjusted solution by a second titration against N/10 hydrochloric acid.

2. Determination of Acidity.—Pipette exactly 10 c.c. of fruit or other juice into a flask or beaker, add 50 to 100 c.c. distilled water and several drops of phenolphthalein (2 grams in 1,000 c.c. of 50 per cent. alcohol) and titrate with N/10 sodium hydroxide until a permanent pink color is obtained.

Highly colored samples, such as grape juice, must be diluted to 500 c.c. or more and more indicator added in order that the color of the sample will not mask the end point of the titration.

In the case of strongly acid products, such as lemon juice or vinegar, 10 c.c. should be diluted to 100 c.c. with distilled water in a volumetric flask. After thorough mixing, withdraw 10 c.c. for determination of acidity, multiplying the result by 10.

Factors.—One c.c. of N/10 sodium hydroxide will neutralize the following equivalents of acid:

Acetic acid	.0060 grams	Tartaric acid	.0075 grams
Citric acid	.0064 grams	Lactic acid	.0090 grams
Malic acid	.0067 grams	Oleic acid	.0282 grams

3. Determination of Alkalinity.—The alkalinity of commercial lye can be determined by weighing exactly 4.000 grams of a representative sample into a dry beaker. The sample should be weighed as quickly as possible to avoid absorption of moisture from the air. Wash the sample into a 1,000-c.c. volumetric flask and dilute to the mark with distilled water. Mix thoroughly and titrate exactly 20 c.c. with N/10 hydrochloric acid, using phenolphthalein indicator. Since 1 c.c. N/10 hydrochloric acid neutralizes .004 grams of sodium hydroxide, if the above directions are followed, each c.c. of acid required is equivalent to 5 per cent. sodium hydroxide in the original sample.

4. Preparation of Standard Silver Nitrate Solution.—Weigh exactly 8.495 grams dry C.P. silver nitrate into a small beaker. Wash into a 500-c.c. volumetric flask with distilled water and dilute to 500 c.c.

If C.P. silver nitrate previously dried three hours at 100°C. is employed, standardization of the solution is not necessary. The normality of the silver nitrate may be verified as follows: Pipette 20 c.c. of N/10 hydrochloric acid into a beaker or flask; add a few c.c. of chromate indicator (5 grams potassium chromate in 100 c.c. distilled water) and titrate until the lemon-yellow color changes to a deeper orange color. Do not continue till a brick-red color is obtained. Exactly 20 c.c. of the silver nitrate solution should be required for this titration.

5. Determination of Sodium Chloride in Brine.—Pipette 10 c.c. of the sample into a 100-c.c. volumetric flask. Dilute to the mark with distilled water and mix thoroughly.

Pipette 20 c.c. of the diluted sample into a beaker or flask, add about

25 c.c. of distilled water and a few c.c. of chromate indicator, and titrate as described in 4.

One c.c. N/10 silver nitrate is equivalent to .00585 grams of sodium chloride. If the above directions are followed each c.c. of N/10 silver nitrate equals 0.29 per cent. sodium chloride in the original sample.

6. Preparation of Standard Iodine and Thiosulphate Solutions:

A. N/20 Iodine.—Weigh exactly 6.346 grams of sublimed iodine crystals into a small beaker. Add about 10 to 15 grams of C.P. potassium iodide and a small amount of distilled water. Stir till the iodine is dissolved, wash into a 1,000-c.c. volumetric flask and dilute to the mark with distilled water.

B. N/20 Sodium Thiosulphate.—Weigh exactly 12.41 grams of C.P. sodium thiosulphate ($Na_2S_2O_3 . 5H_2O$) into a small beaker; dissolve in distilled water; wash into a 1,000-c.c. volumetric flask and dilute to the mark.

C. Standardization.—Weigh exactly 2.4516 grams of C.P. potassium dichromate into a small beaker. Dissolve and wash into a 1,000-c.c. volumetric flask. Dilute to mark with distilled water. Prepare a solution containing approximately 10 grams of C.P. potassium iodide in 100 c.c. of distilled water.

Place 10 c.c. of this potassium iodide solution and 50 c.c. of distilled water in a 200-c.c. Erlenmeyer flask. Add 5 c.c. concentrated hydrochloric acid, and exactly 20 c.c. of the N/20 dichromate solution. Add a few drops of starch indicator (prepared by boiling 1 gram of starch in 100 c.c. distilled water and preserving with a few drops of chloroform). Titrate with the sodium thiosulphate solution until the blue color just disappears.

Since 20 c.c. of the N/20 potassium dichromate solution was used, 20 c.c. of the thiosulphate solution should be required to react with the iodine liberated by the dichromate from the potassium iodide solution. The normality of the thiosulphate solution can be determined by dividing 20 by the c.c. of thiosulphate solution used, and multiplying by .05.

Example: 21.4 c.c. of thiosulphate used.

$$\text{Normality} = \frac{20}{21.4} \times .05 = .0467 \text{ N.}$$

To determine the normality of the iodine solution proceed as follows: Pipette 20 c.c. of the iodine solution into a flask or beaker. Add a few drops of starch indicator and titrate with thiosulphate solution till the blue color just disappears. The normality of the iodine is then obtained from the following formula:

$$\frac{\text{c.c. thiosulphate used}}{20} \times \text{normality of thiosulphate sol.}$$

Example: Thiosulphate solution used = 21.3 c.c.

$$\text{Normality of iodine solution} = \frac{21.3}{20} \times 0.467 = .04973 \text{ N}$$

7. Approximate Determination of Total Sulphurous Acid:

A. Place 50 grams of finely ground dried fruit, or other sample, in a 500-c.c. distillation flask. Add about 300 c.c. of distilled water and 5 c.c. of 20 per cent. phosphoric acid solution.

B. Connect the flask to a glass condenser and allow the outlet of the condenser to dip beneath the surface of 50 c.c. of N/20 iodine solution in a 500-c.c. Erlenmeyer flask.

C. Add not over 1 gram of sodium bicarbonate to the distillation flask and quickly insert the rubber stopper connecting to the condenser. Distill over about 200 c.c. into the flask containing the iodine solution. If all the iodine in the receiving flask is discharged before the distillation is complete add more N/20 iodine solution.

D. Add a few drops of starch indicator to the distillate and titrate the excess iodine with N/20 sodium thiosulphate solution until the blue color just disappears, leaving a water-white solution.

E. Report the sulphurous acid content in milligrams per kilogram (parts per million) or mgms. per liter of sample. One c.c. N/20 iodine equals .0016 gms., or 1.6 mgms. sulphur dioxide.

8. Preparation of Fehling's Solutions:

A. Copper Sulphate Solution.—Dissolve 34.639 grams of C.P. copper sulphate ($Cu\ SO_4.\ 5H_2O$) in water and dilute to 500 c.c.

B. Alkaline Tartrate Solution.—Dissolve 173 grams C.P. or U. S. P. Rochelle salts (sodium potassium tartrate) and 50 grams stick sodium hydroxide in distilled water and dilute to 500 c.c. Mix and allow to settle.

9. Determination of Sugar:

A. Total Sugar.—Preparing the Solution: Weigh exactly an amount of sample which when dissolved in distilled water and diluted to 500 or 1,000 c.c. in a volumetric flask will give a solution containing not more than 1 per cent. of sugar.

Liquid products, such as juices, beverages and syrups, are merely diluted without heating. Solid materials, such as fresh or dried fruits, must be ground thoroughly before sampling and the weighed sample boiled vigorously in water to disintegrate the sample and extract the sugar.

In the case of *dried fruits,* a representative sample of 1 pound should be ground several times through a fine food-chopper with a nut-butter attachment, 10 grams placed in a 1,000-c.c. volumetric flask and boiled vigorously in 200 to 300 c.c. distilled water for 15 to 20 minutes.

Clarifying the Solution: Add to the cooled sugar solution small quantities of Horne's lead sub-acetate on the tip of a knife-blade, shaking after each addition until the solution clarifies sharply; that is, the solid particles settle rapidly, leaving a practically clear supernatant liquid. Fill to the mark with water, mix thoroughly and allow to stand overnight.

Removing Excess Lead: Mix and filter about 50 c.c. through a filter paper and add sufficient anhydrous sodium oxalate to precipitate all excess lead. Mix and filter again. Test the filtrate with a crystal of sodium oxalate to ascertain if free of lead.

Inverting the Sucrose: Pipette 25 c.c. of the clear filtrate into a 250-c.c. beaker, add about 5 c.c. concentrated hydrochloric acid and 10 c.c. water. Heat in a water bath at about 70°C. for 10 minutes. Add a few drops of indicator and make the solution approximately neutral with 20 per cent. sodium hydroxide (about 10 c.c. is required).

Precipitating the Cuprous Oxide: Add 25 c.c. each of the copper sulphate and alkaline tartrate solutions described in 8. Cover the beaker with a watch-glass and heat over a Bunsen burner so that boiling begins in about 4 minutes and continues *exactly* 2 minutes. Filter at once in a previously dried and weighed Gooch crucible, using gentle suction. (The asbestos should be digested previously with acid and alkali and washed with distilled water.) Wash all the red cuprous oxide into the crucible and wash with hot distilled water until free of soluble salts. Dry the crucible in an oven at about 100°C. for an hour or longer, cool and weigh.

Calculating the Result: From the weight of cuprous oxide obtained find the equivalent weight of invert sugar from Munson and Walker's Tables.[1]

Example:

Milligrams of cuprous oxide obtained = 250.0

Milligrams of invert sugar equivalent to = 116.4

Milligrams of original sample represented

$$\left(\frac{25 \text{ c.c.}}{1000 \text{ c.c.}} \times 10 \text{ grams}\right) = 250.0$$

Percentage of total sugar as invert sugar

$$\frac{116.4}{250.0} = 46.36 \text{ per cent.}$$

B. Invert Sugar (Dextrose and Levulose).—In products containing only invert sugar, such as grape juice or raisins, the inversion of sucrose is omitted.

[1] Page 321, Methods Analysis of the Official Agricultural Chemist—1920; or page 599, Food Inspection and Analysis.—Leach.

C. Cane Sugar (Sucrose).—In products containing only sucrose, after inversion and determination of the sucrose as invert sugar, the percentage of invert sugar multiplied by 0.95 gives the percentage of sucrose in the sample.

D. Cane Sugar and Invert Sugar.—Where it is desired to determine both kinds of sugar present in a sample, determine (a) Invert sugar in one aliquot without inversion, (b) Total sugar in another aliquot after inversion. The percentage of total sugar as invert sugar minus the percentage of invert sugar obtained without inversion gives the percentage of invert sugar resulting from the inversion of the cane sugar, which, multiplied by 0.95, gives the percentage of cane sugar (sucrose).

10. Determination of Moisture:

A. Samples Not Containing Invert Sugar.—Weigh exactly 10 grams of finely ground sample into a flat tared dish and dry to constant weight in an oven at not over 100°C. (212°F.). The loss in weight in grams multiplied by 10 gives the percentage of moisture.

B. Samples Containing Invert Sugar, such as Fruits, Honey, etc.—Proceed as in 10 *A*, but conduct the drying for 12 hours in a vacuum oven at 70°C. (158°F.) and not over 4 inches mercury pressure.

11. Detection of Benzoate of Soda.—Acidify the sample, such as jam, jelly, catsup, cider, etc., with dilute sulphurous acid, after diluting with water if necessary. Shake in a separatory funnel with an equal volume of chloroform. Draw off the chloroform layer and evaporate it to dryness in a porcelain dish. Dissolve the residue in dilute ammonia and evaporate to dryness over a water bath. Dissolve the residue in a small amount of warm water, filtering if necessary. Add a few drops of neutral 0.5 per cent. ferric chloride solution. A brownish precipitate indicates the presence of benzoic acid. (A violet color indicates salicylic acid.)

12. Detection of Coal-tar Dye.—Boil a strip of white pure-wool yarn or cloth for 5 to 15 minutes in a 20- to 100-gram sample of the product diluted with an equal volume of water. Remove the cloth and rinse thoroughly. Acidify the diluted sample with several drops of concentrated hydrochloric acid and heat again with another piece of wool. Remove the cloth and rinse thoroughly. If the cloth takes up any considerable color in either case, the presence of coal-tar dye is indicated.

Pure Food and Drug Regulations permit the use of the following eight certified colors in food products, if labeled "artificially colored": Orange I, Erythrosine, Indigo Carmine, Amaranth, Tartrazine, Napthol Yellow S, Ponceau 3 R, Light Green S. F. Yellowish. For the separation and identification of these and non-permissible coal-tar dyes, see "Methods of Analysis of the Association of Official Agricultural Chemists, Washington, D. C."

TABLE XIII.—TEMPERATURE CORRECTIONS FOR BALLING HYDROMETER.

To use the table, the apparent sugar percentage (Balling degree) of the syrup is determined by hydrometer and the temperature observed. Opposite the indicated temperature and in the column below the indicated sugar percentage will be found the amount to be added or subtracted from the observed reading.

Example:

Observed sugar..... .50 per cent.
Observed temperature.....115° F.

Opposite 115° F. and below 50 per cent is found 2.32. This is then added to 50 per cent, making 52.32, corrected Balling degree.

Temp. Fahr.	Temp. Cent.	10°	20°	30°	40°	60°	75° Balling
		Corrections to be subtracted from degrees Balling					
32	0	.41	.62	.82	.98	1.22	1.29
41	5	.37	.52	.65	.75	.88	.94
50	10	.29	.36	.42	.49	.54	.61
54	12.2	.22	.26	.31	.34	.40	.46
57	13.9	.16	.18	.21	.22	.26	.32
61	16.1	.08	.10	.11	.12	.14	.18
62	16.7	.03	.03	.04	.04	.05	.06
		Corrections to be added to degrees Balling					
64	17.78	.03	.03	.03	.03	.03	.02
68	20.00	.08	.09	.10	.10	.10	.06
72	22.33	.29	.31	.32	.33	.32	.25
75	23.89	.41	.44	.46	.47	.46	.40
79	26.11	.54	.58	.61	.62	.62	.55
82	27.78	.68	.72	.76	.78	.78	.70
86	30.00	.82	.92	.94	.98	.88	.86
90	32.23	.98	1.03	1.08	1.10	1.10	.98
93	33.89	1.14	1.21	1.24	1.28	1.26	1.17
97	36.11	1.32	1.38	1.41	1.46	1.42	1.33
100	37.78	1.49	1.55	1.59	1.64	1.60	1.49
104	40.00	1.67	1.73	1.79	1.82	1.78	1.65
108	42.23	1.86	1.93	1.99	2.00	1.96	1.81
110	43.34	1.96	2.03	2.09	2.10	2.05	1.89
112	44.45	2.06	2.13	2.19	2.20	2.14	1.97
115	46.11	2.27	2.34	2.39	2.40	2.32	2.35
117	47.23	2.38	2.45	2.49	2.50	2.41	2.24
119	48.34	2.49	2.56	2.59	2.60	2.50	2.23
121	49.45	2.60	2.67	2.69	2.70	2.60	2.42
112	50.00	2.71	2.78	2.80	2.80	2.70	2.51
124	51.11	2.81	2.89	2.90	2.91	2.80	2.60
126	52.23	2.92	3.00	3.01	3.02	2.90	2.69
128	53.34	3.03	3.11	3.12	3.13	3.00	2.78
130	54.45	3.14	3.22	3.23	3.24	3.10	2.87
131	55.00	3.26	3.33	3.33	3.29	3.20	2.93
133	66.11	3.39	3.44	3.44	3.46	3.30	3.05
135	57.23	3.52	3.55	3.55	3.57	3.40	3.14
137	58.34	3.64	3.66	3.66	3.68	3.50	3.23
139	59.45	3.76	3.77	3.77	3.79	3.60	3.32
140	60.00	3.82	3.88	3.88	3.90	3.70	3.41
149	65.00	4.53	4.51	4.49	4.48	4.21	3.88
158	70.00	5.18	5.14	5.10	5.06	4.32	4.35
167	75.00	6.00	5.84	5.74	5.66	5.27	4.84
176	80.00	6.62	6.54	6.38	6.26	6.82	5.33
185	85.00	7.44	7.30	7.10	6.92	6.39	5.85
194	90.00	8.26	8.06	7.85	7.68	6.58	6.37
203	95.00	9.14	8.89	8.61	8.35	7.59	6.90
212	100.00	10.10	9.72	9.39	9.03	8.22	7.42

TABLE XIV.—RELATION OF SPECIFIC GRAVITY, BAUMÉ AND BALLING READINGS OF SALT, SUGAR AND SODA LYE SOLUTIONS AT 20°C. (68°F.)
(From Cruess, Home and Farm Food Preservation)

Spec. grav.	Salt		Sugar		Soda lye	
	Baumé degree	Oz.* per gal.	Balling. per cent sugar	Oz.* per gal.	Per cent	Oz.* per gal.
1.007	1	1.3	1.8	2.3	0.5	0.7
1.014	2	2.6	3.6	4.8	1.2	1.5
1.022	3	4.0	5.5	7.5	1.8	2.4
1.029	4	5.3	7.2	9.9	2.5	3.2
1.036	5	6.7	9.0	12.6	3.1	4.1
1.045	6	8.1	10.8	15.5	3.7	5.0
1.052	7	9.6	12.6	18.5	4.5	6.0
1.060	8	11.1	14.5	21.7	5.2	7.0
1.067	9	12.7	16.2	24.7	5.8	8.0
1.075	10	14.2	18.1	28.3	6.6	9.0
1.083	11	15.8	19.8	31.6	7.3	10.1
1.091	12	17.5	21.7	35.5	8.1	11.3
1.100	13	19.1	23.5	39.3	8.8	12.4
1.108	14	20.8	25.3	43.3	9.5	13.5
1.116	15	22.6	27.2	47.8	10.3	14.7
1.125	16	24.4	29.1	52.5	11.1	15.9
1.134	17	26.2	30.9	57.2	11.9	17.3
1.142	18	28.1	32.7	62.2	12.7	18.6
1.152	19	30.0	34.6	67.7	13.5	19.9
1.162	20	32.0	36.5	73.6	14.3	21.3
1.171	21	34.0	38.3	79.5	15.1	22.7
1.180	22	36.1	40.1	85.7	16.0	24.2
1.190	23	38.2	42.0	92.7	16.9	25.7
1.200	24	40.4	43.9	100.2	17.8	27.3
1.210	25	42.7	45.9	108.6	18.7	29.0
1.220	26	45.0	47.7	116.7	19.6	30.7
1.231	27	47.3	49.6	126.0	20.6	32.5
1.241	28	49.8	51.6	136.5	21.5	34.2
1.252	29	52.3	53.5	147.3	22.5	36.1
1.263	30	54.9	55.4	159.0	23.5	38.0
1.274	31	57.5	57.3	171.8	24.5	39.9
1.285	32	60.2	59.3	186.5	25.5	41.9
1.297	33	63.0	61.2	201.9	26.6	44.1
1.308	34	66.0	63.2	219.8	27.6	46.3
1.320	35	69.0	65.2	240.0	28.8	48.7
1.332	36	72.0	67.2	262.2	30.0	51.1
1.345	37	75.2	69.2	287.6	31.2	53.7
1.361	38	78.4	71.2	316.4	32.4	56.4

* Ounces of material to be added to one gallon of water.

TABLE XV.—MINIMUM DRAINED WEIGHTS FOR CANNED FRUITS AND VEGETABLES

The following minimum drained weights have been adopted by the United States Department of Agriculture, Bureau of Chemistry, in the enforcement of the Pure Food and Drugs Act. In each case, the drained or "cut-out" weight is obtained by draining the contents of the can on a piece of 1/8-inch mesh screen for 2 minutes. The proper filling of canned fruits and vegetables not mentioned in this table is determined by visual inspection, no definite weights having been found practicable.

Material	Size of can No.	Drained weight (ozs.)	Remarks
Beans, Wax and Refugee.	1	6	
	2	11½	Whole beans
	2	12	Cut beans
	10	61	Whole beans
	10	65	Cut beans
Beans, green lima.....	1	8	
	2	13½	
	10	72	
Cherries, unpitted.....	1	10½	
	2	12	Syrup cut-out above 20°
	2	13	Syrup cut-out below 20°
	2½	18	Syrup cut-out above 20°
	2½	19	Syrup cut-out below 20°
	10	68	Syrup cut-out above 20°
	10	72	Syrup cut-out below 20°
Cherries, pitted.....	1	7½	Syrup cut-out above 20°
	2	12½	Syrup cut-out below 20°
	2	13½	Syrup cut-out above 20°
	2½	18½	Syrup cut out above 20°
	2½	19½	Syrup cut-out below 20°
	10	70	Packed in water
Corn, Maryland style....	2	13½	
Peaches, halves or slices .	1	10½	
	2	13½	
	2½	20	
	10	68	Not pie fruit
Pears.....	1	10–1/2	
	2	13	
	2½	19	
	3	22	
	10	67	
Peas.....	1	7½	
	2	13½	
	10	72	
Sauerkraut.....	2	16	
	2½	23	
	3	27	
	10	80	
Spinach.....	2	13	
	2½	19	
	3	21½	
	10	66	

TABLE XVI.—RELATION OF THE BOILING POINT OF WATER TO VACUUM.

Vacuum in. Mercury	Temp. ° Fahr.	Vacuum in. Mercury	Temp. ° Fahr.	Vacuum in. Mercury	Temp. ° Fahr.
29.0	79.07	19.0	165.42	9.0	194.52
28.0	101.15	18.0	169.14	8.0	196.73
27.0	115.06	17.0	172.63	7.0	198.87
26.0	125.38	16.0	175.93	6.0	200.94
25.0	133.77	15.0	179.03	5.0	202.92
24.0	140.64	14.0	181.92	4.0	204.85
23.0	146.78	13.0	184.68	3.0	206.71
22.0	152.16	12.0	187.31	2.0	208.52
21.0	157.00	11.0	189.83	1.0	210.28
20.0	161.42	10.0	192.23	0.0*	212.00

* Zero vacuum is atmospheric pressure or 14.7 lb. absolute pressure.

TABLE XVII.—BOILING POINT OF WATER AT DIFFERENT ALTITUDES ABOVE SEA LEVEL.

Altitude (Feet)	Boiling Point		Altitude (Feet)	Boiling Point		Altitude (Feet)	Boiling Point	
	°F.	°C.		°F.	°C.		°F.	°C.
0	212	100	4169	204	96	7381	197	92
1025	210	99	5225	202	94	8481	196	91
2063	208	98	6304	200	93	9031	195	90
3115	206	97						

TABLE XVIII.—SIZE AND CAPACITY OF STANDARD SANITARY CANS USED FOR FRUITS AND VEGETABLES.

Number of Can	Diameter in Inches	Height in Inches	Capacity in Fluid Ounces
1 (Eastern Oyster)	$2\frac{11}{16}$	4	12
1 Tall Calif.	3	$4\frac{5}{8}$	12
1 Flat Calif.	4	$2\frac{3}{8}$	16
2	$3\frac{3}{8}$	$4\frac{1}{2}$	21
$2\frac{1}{2}$	4	$4\frac{3}{4}$	31
3	$4\frac{1}{4}$	$4\frac{7}{8}$	35
10	$6\frac{1}{8}$	7	107
12	$6\frac{1}{8}$	$8\frac{3}{4}$	128

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